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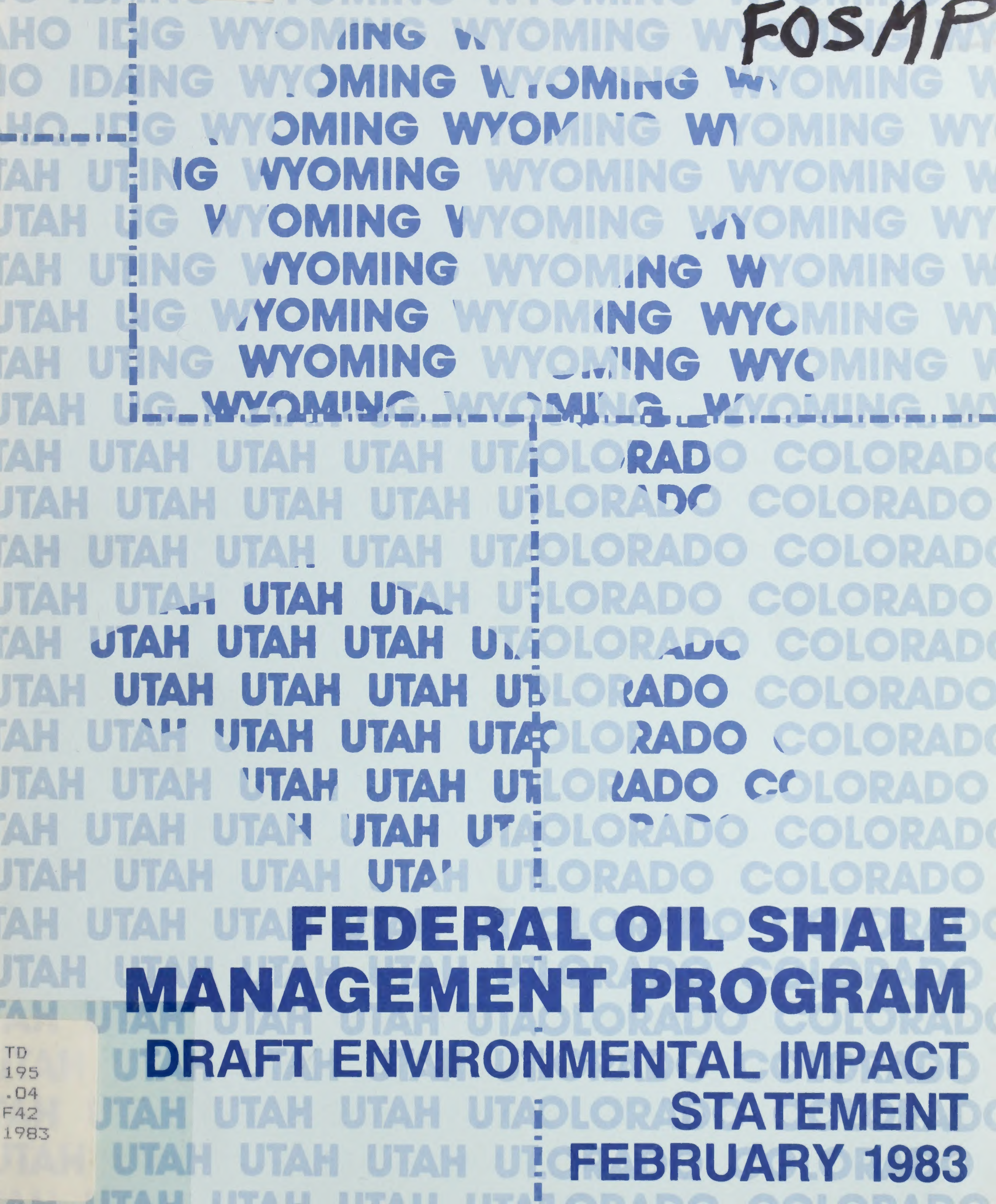

FEDERAL OIL SHALE MANAGEMENT PROGRAM

DRAFT ENVIRONMENTAL IMPACT STATEMENT

FEBRUARY 1983

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IN REPLY REFER TO:
3900 (543)

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
WASHINGTON, D.C. 20240

JAN 10 1983

Dear Reviewer:

The draft environmental impact statement (DEIS) and proposed regulations on the Federal Oil Shale Management Program are submitted for your review and comment. Please keep the draft EIS, as we may print only an abbreviated final EIS which will be an addendum to this draft. The final EIS will be prepared considering the comments received through the public review process on the adequacy of the contents of the draft.

All written comments on the draft EIS should be sent to Jack Edwards, at the address shown on the cover sheet, no later than April 11, 1983. As indicated elsewhere in the EIS, a series of public meetings will be held March 14 through March 29, 1983, to receive oral comments at the dates, locations, and places shown later in the EIS. The purpose of these meetings will also be to receive comments on the draft regulations which are incorporated by reference in this EIS. Written comments on the regulations are also due by April 11, 1983 and should be sent to Director (140), Bureau of Land Management, 1800 C Street, N.W., Washington, D.C. 20240.

Comments should be as specific as possible and address the adequacy of the scope of the EIS or the impact analyses of the proposed action and alternatives. If methodologies used to predict the impacts are considered inadequate, the reviewer's comment should describe the rationale for the procedures of the preferred alternative methodology.

A copy of the final EIS will be sent to all who provide substantive comments on the draft EIS or who request a copy.

In accordance with the Council on Environmental Quality (CEQ) regulations of November 29, 1978, this draft incorporates a number of other documents by reference. The locations of these other documents are noted in the literature cited section included in the text volume. The supporting air quality technical report for the EIS can be obtained from Jack Edwards at the address shown on the cover sheet.

Please be advised that the adoption of the proposed action (i.e., final regulations) does not authorize the potential impacts presented in this draft EIS. The EIS does, however, present impacts which could occur if the proposed action is adopted then implemented via leasing actions.

Sincerely,

Robt F Burford

Director

Enclosure

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DEPARTMENT OF THE INTERIOR

DRAFT ENVIRONMENTAL IMPACT STATEMENT

on the

FEDERAL OIL SHALE MANAGEMENT PROGRAM

Prepared by

Bureau of Land Management

February 1983

Robt F Burford

Director, BLM

COVER SHEET

Federal Oil Shale Management Program
Environmental Impact Statement

(X) Draft   (   ) Final

LEAD AGENCY

U.S. Department of the Interior, Bureau of Land Management

COOPERATING AGENCIES

U.S. Department of the Interior, Fish and Wildlife Service
Environmental Protection Agency

STATES, COUNTIES, AND RESERVATIONS THAT COULD BE DIRECTLY AFFECTED

State of Colorado
- Garfield County
- Mesa County
- Rio Blanco County

State of Utah
- Carbon County
- Duchesne County
- Grand County
- Uintah County

State of Wyoming
- Carbon County
- Lincoln County
- Sublette County
- Sweetwater County
- Uinta County

Uintah and Ouray Indian Reservation

ABSTRACT

The action proposed in the EIS is the adoption of codified regulations for a federal oil shale management program. Determining leasing levels that could result from implementing this program is the basis for quantifying impacts on this EIS. Draft regulations for implementing the proposed program are being published at the same time as the draft EIS.

The statement assesses the cumulative impacts of development and impacts of production of federal oil shale that could result from adopting the proposed regulations in the oil shale region of Colorado, Utah and Wyoming, for 1990 and 2000. Three major types of alternatives are evaluated: (1) no action (no permanent federal leasing program); (2) program alternatives (oil shale activity planning, concessionary leasing, direct leasing, and prototype leasing); and (3) conservation and alternative energy sources.

The major environmental issues addressed are those which were identified in the scoping process: air quality, socioeconomics, water resources and wildlife.

EIS CONTACT

Questions and comments on the EIS should be directed to:

Jack D. Edwards, Team Leader
Bureau of Land Management
Division of EIS Services
555 Zang Street, First Floor East
Denver, Colorado 80228
Telephone (303) 234-6737/FTS 234-6737

REGULATIONS CONTACT

Questions and comments on the regulations (43 CFR 3900) should be directed to:

Donald W. Brabson
Branch of Tar Sands and Oil Shale
Bureau of Land Management
Washington, D.C. 20240
Telephone (202) 343-3258/FTS 343-3258

DATE BY WHICH COMMENTS ON THE DRAFT EIS MUST BE RECEIVED: April 11, 1983

DATE BY WHICH COMMENTS ON THE REGULATIONS MUST BE RECEIVED: April 11, 1983

DATE STATEMENT MADE AVAILABLE TO THE ENVIRONMENTAL PROTECTION AGENCY AND THE PUBLIC:

Draft: February 4, 1983

TABLE OF CONTENTS

Page

Public Hearing Information
Summary S-1

Chapter 1: Description of Proposed Action and Alternatives 1-1
  Introduction 1-1
    Purpose and Need of Proposed Action 1-1
    Location of Proposed Action 1-1
    Authorizing Actions 1-1
    Interrelationships 1-1
  History and Background of Oil Shale Leasing 1-2
  Proposed Action 1-6
    Legal Context for Program 1-8
    Mitigation Included in Proposed Action 1-11
  Alternatives 1-12
    No Action 1-12
    Program Alternatives 1-12
      Activity Planning Program 1-12
      Concessionary Leasing Program 1-15
      Direct Leasing Program 1-16
      Prototype Leasing Program 1-16
    Energy Conservation Alternative 1-16
    Alternative Energy Fuels 1-17

Chapter 2: Description of Affected Environment 2-1
  Introduction 2-1
  Location and Description of Oil Shale Reserves 2-1
  Affected Environment 2-5
    Air Quality 2-5
    Socioeconomics 2-6
    Quality of Life 2-8
    Water Resources 2-10
      Ground Water 2-10
      Surface Water 2-10
    Vegetation/Soils/Agriculture 2-11
      Vegetation 2-11
      Soils 2-12
      Agriculture 2-13
    Wildlife 2-14

Page

Recreation Resources 2-15
Wilderness 2-17
Visual Resources 2-17
Cultural Resources 2-18
Mineral Resources 2-19
Paleontology 2-19
Transportation Networks 2-20

Chapter 3: Environmental Consequences 3-1
Introduction 3-1
General Impacts 3-5
Ground Water 3-5
Health and Safety 3-6
Hazardous Wastes 3-9
Reclamation 3-10
Threatened or Endangered Species 3-10
Cultural Resources 3-10
Paleontology 3-11
Net Energy Analysis 3-11
Federal Land Management 3-12
No Action Alternative 3-13
Low Level 3-13
Air Quality 3-13
Socioeconomics 3-13
Quality of Life 3-14
Surface Water Resources 3-15
Vegetation/Soils/Agriculture 3-16
Wildlife 3-16
Recreation Resources 3-17
Wilderness 3-18
Visual Resources 3-18
Cultural Resources 3-19
Mineral Resources 3-19
Transportation Networks 3-19
High Level 3-20
Air Quality 3-20
Socioeconomics 3-20
Quality of Life 3-20
Surface Water Resources 3-21
Vegetation/Soils/Agriculture 3-21
Wildlife 3-22
Recreation Resources 3-22
Wilderness 3-22
Visual Resources 3-23
Cultural Resources 3-23
Mineral Resources 3-23
Transportation Networks 3-23

Page

Proposed Action 3-23
  Low Level 3-23
    Air Quality 3-23
    Socioeconomics 3-24
    Quality of Life 3-27
    Surface Water Resources 3-28
    Vegetation/Soils/Agriculture 3-28
    Wildlife 3-28
    Recreation Resources 3-29
    Wilderness 3-29
    Visual Resources 3-29
    Cultural Resources 3-29
    Mineral Resources 3-29
    Transportation Networks 3-30
  High Level 3-30
    Air Quality 3-30
    Socioeconomics 3-30
    Quality of Life 3-38
    Surface Water Resources 3-39
    Vegetation/Soils/Agriculture 3-39
    Wildlife 3-39
    Recreation Resources 3-40
    Wilderness 3-40
    Visual Resources 3-41
    Cultural Resources 3-41
    Mineral Resources 3-41
    Transportation Networks 3-41
Program Alternatives 3-41
  Activity Planning Program, Concessionary Leasing Program, and Direct Leasing Program 3-41
    Prototype Leasing Program 3-41
Energy Conservation Alternative 3-41
Alternative Energy Fuels 3-42

Chapter 4: Comparative Analysis 4-1
    Introduction 4-1
    Air Quality 4-1
    Socioeconomics 4-1
    Quality of Life 4-3
    Surface and Ground Water Resources 4-3
    Agriculture 4-3
    Wildlife 4-4
    Safety and Health and Hazardous Waste 4-4
    Recreation Resources and Wilderness 4-4
    Cultural Resources 4-4
    Transportation Networks 4-5
    Visual Resources 4-5

Chapter 5: Long-Term Environmental Consequences 5-1

References Cited RC-1
Glossary G-1
List of Preparers P-1

APPENDICES

Appendix		Page
1	Consultation and Coordination	A-1-1
2	Methodology	A-2-1
3	History of Oil Shale Development	A-3-1
4	Project Data Used in Developing No-Action Alternative and Proposed Action Analyses	A-4-1
5	Typical Oil Shale Development Technologies	A-5-1

TABLES

Table		Page
1-1	Lease Sales in Colorado, Utah and Wyoming	1-4
1-2	Utah State Oil Leases	1-5
1-3	Federal Laws Affecting Oil Shale Development	1-9
2-1	Oil Shale Reserves in the United States	2-2
2-2	Oil Shale Potential of the Green River Formation	2-5
2-3	Population Figures for Affected Colorado Counties	2-8
2-4	Employment Figures for Affected Colorado Counties	2-8
2-5	Population and Employment Figures for Affected Utah Counties	2-9
2-6	Population and Employment Figures for Affected Wyoming Counties	2-9
2-7	Characteristics of Major Rivers	2-11
2-8	Vegetation Types Within Oil Shale Region	2-12
2-9	Private Crop Land and Pasture Land Within Oil Shale Region	2-14
2-10	AUMs of Forage and Livestock Numbers within Oil Shale Region	2-14
2-11	Threatened or Endangered Wildlife Species within Oil Shale Region	2-16
2-12	Federal Wilderness Units Within Oil Shale Region	2-18
3-1	No-Action Alternative Data Summary	3-4
3-2	Proposed Action Data Summary	3-5
3-3	Summary of Occupational Hazards Associated with Oil Shale Development	3-8
3-4	Energy Requirements at the Mines of Various Oil Shale Production Levels	3-12
3-5	Comparison of Efficiences of Energy Production From Oil Shale and Other Energy Sources	3-14

Table		Page
3-6	Average 24-Hour Pollutant Concentrations (ug/m^3) for Class I areas, No-Action Alternative, Low Level	3-14
3-7	Projected Population and Employment Levels, No-Action Alternative, Low Level	3-14
3-8	Wildlife Impacts, No-Action Alternative, Low Level	3-17
3-9	Range of 24-Hour Pollutant Modeled Concentrations, No-Action Alternative, High Level	3-20
3-10	Projected Population and Employment Levels, No-Action Alternative, High Level	3-21
3-11	Wildlife Impacts, No-Action Alternative, High Level	3-22
3-12	Range of 24-Hour Pollutant Modeled Concentrations, Proposed Action, Low Level	3-24
3-13	Potential Total Atmospheric Deposition on Class I Areas, Proposed Action, Low Level	3-27
3-14	Projected Population and Employment Levels, Proposed Action, Low Level	3-27
3-15	Wildlife Impacts, Proposed Action, Low Level, 2000	3-29
3-16	Range of 24-Hour Pollutant Modeled Concentrations, Proposed Action, High Level	3-33
3-17	Potential Total Atmospheric Deposition on Class I Areas, Proposed Action, High Level, 2000	3-38
3-18	Population and Employment Impacts, Proposed Action, High Level	3-38
3-19	Wildlife Impacts, Proposed Action, High Level, 2000	3-40
4-1	Differences in Impacts Between No-Action Alternative and Proposed Action, 2000	4-2

FIGURES

Figure		Page
1-1	Oil Shale Leases Within Oil Shale Region	1-3
1-2	A Comparison of the Proposed Action and Alternatives	1-13
2-1	Oil Shale Resources of the United States	2-3
3-1	Analysis Combinations	3-2
3-2	Cumulative 24-hour TSP Concentrations, Proposed Action, Low Level, 2000	3-25
3-3	Cumulative 24-hour SO_2 Concentrations, Proposed Action, Low Level, 2000	3-26
3-4	Cumulative 24-hour TSP Concentrations, Proposed Action, High Level, 2000	3-34
3-5	Cumulative 24-Hour SO_2 Concentrations, Proposed Action, High Level, 2000	3-35

MAPS

Map		Page
2-1	(Map) Programmatic oil shale region	2-4

PUBLIC HEARING INFORMATION

A public hearing on the proposed Oil Shale Management Regulations and draft Environmental Impact Statement (EIS) for the Federal Oil Shale Management Program will be held:

Location: **Date:** March 29, 1983

Howard Johnson's
I-70 at Horizon Drive
Grand Junction, CO 81501
Ph. (303) 243-5150

Time: 2:00 p.m. (approximate)

(The public hearing will be held directly after the Regional Oil Shale Team meeting which begins at 8:30 a.m. on March 29, 1983, at Howard Johnson's in Grand Junction.)

A continuation of the hearing into the evening may be scheduled if sufficient requests are made in advance or requested at the afternoon hearing (registration form incorporated as the last page of this EIS).

The hearing will be held pursuant to the objectives of the National Environmental Policy Act (PL 9-1190; 83 Stat. 852,853) to receive comments (testimony on the scope of the EIS and the adequacy of the impact analysis and the proposed oil shale management regulations). Testimony presented at these hearings will be considered in the preparation of the final EIS.)

The public hearing will be conducted by a Bureau of Land Management (BLM) official who will be accompanied by other BLM personnel involved in preparing this draft EIS. The panel members may ask questions of the witness to clarify points in the testimony. All hearing proceedings will be recorded.

Before giving testimony at the public hearing, participants are requested to complete a hearing registration form. A REGISTRATION FORM IS INCORPORATED AS THE LAST PAGE OF THIS VOLUME. Additional forms may be obtained from the address shown on the registration form. Registration forms must be returned to that address no later than March 25, 1983. Participants may also register at the registration desk.

Time preferences for presentation of oral statements will be honored whenever possible. A tentative listing of speakers, in the order they will be called, will be available at the registration desk.

After the last witness has been heard, the hearing administrator will consider the requests of other persons present who wish to testify. Only one witness will be allowed to present a single viewpoint of a single organization. However, any witness will be permitted to give relevant testimony if it is offered as the opinion of a private citizen.

Persons wishing to give oral testimony will be limited to 10 minutes. Written submissions may also be presented at the hearing.

To allow the public to prepare for this hearing, public information session(s) will be held. Tentatively, the schedule is:

LOCATION	**DATE**	**TIME**
Rock Springs, WY	March 14, 1983	7 p.m.
Vernal, UT	March 15, 1983	7 p.m.
Grand Junction, CO	March 16, 1983	7 p.m.
Denver, CO	March 17, 1983	1 p.m.

Appropriate newspaper and other media notices noting times, dates, and places will be forthcoming.

SUMMARY

INTRODUCTION

The Department of the Interior is considering adoption of a program for long-term leasing of oil shale reserves (proposed action). The detailed procedures for the proposed program are contained in a set of draft regulations. These draft regulations will be published in the Federal Register and made available for public review at the same time that the draft environmental impact statement (EIS) is made available. Therefore, the regulations are incorporated into this EIS by reference.

Projecting impacts of a program (which is proposed rulemaking) is speculative. Only general, region-wide impacts are identified. The program procedures require additional land-use planning and development of detailed mine plan(s). Additional National Environmental Policy Act (NEPA) compliance procedures are integrated into each of these steps. Therefore, prior to leasing and then development, more specific environmental analyses will be accomplished which will identify more site-specific mitigation measures which would reduce many of the adverse impacts identified in this EIS.

In order to assess the possible impacts, a series of assumptions were developed (see Chapter 3, Introduction). Briefly, two levels (low and high) of possible development were assumed in order to predict a range of impacts that could result from implementing the proposed program. The high level assumed favorable economics, a favorable climate for government subsidies, improved technologies, favorable interest rates, and a less stable world situation that discourages oil imports. The low-level assumptions were the reverse of those identified for the high level. This range was felt necessary because of the present uncertainties in the oil shale industry.

In addition to assuming a low and high level of development, two time periods of analysis were selected, 1990 and 2000. The 1990 analysis point was based on the expectation that current oil shale projects already proposed or under development would be in operation by then. The 2000 date was based on the possibility that, with the adoption of the proposed action, new federal leases may occur in the remainder of this decade and may be in operation by 2000. Due to a lack of data, only operational impacts were analyzed. Therefore, since it normally requires a minimum of 10 years to place a lease into operation, impacts of the proposed action were not analyzed for 1990.

The following situations are assessed in this EIS:

1. Proposed Action (proposed program)
2. No-Action Alternative
3. Program Alternatives
4. Energy Conservation Alternative
5. Alternative Energy Fuels

These are briefly described below:

Proposed Action

The proposed action is the adoption of a permanent oil shale program with a set of codified regulations. The following steps would be involved.

1. Preparation or use of Bureau of Land Management (BLM) resource management plans (RMP's) with early industry input to identify oil shale lease tracts within areas acceptable for oil shale development.
2. Public/state consultation on oil shale development through a Regional Oil Shale Team (ROST), including development of a leasing schedule.
3. Initiation of a competitive leasing system which assures a return to the government based on fair market value.
4. Allowance for provisions for diligence, royalty rates, rentals, lease terms, lease modifications, lease transfers, and lease cancellations.

No-Action Alternative

The No-Action Alternative would not consist of any long-term leasing programs for oil shale reserves. A major assumption under this alternative is that federal rights-of-way needed for oil shale development on state and private leases would be granted as needed. The No-Action Alternative would also include the existing prototype leases, as well as the additional leasing proposed for 1983 under the prototype program.

Program Alternatives

The following program alternatives involve specific modifications to the proposed oil shale program.

ACTIVITY PLANNING PROGRAM

The states of Colorado, Utah, and Wyoming proposed this alternative approach to the oil shale program which would involve the following steps.

1. Preparation of regulations and general land-use plans to identify oil shale priority use areas.
2. Implementation of the program including tract delineation, activity planning, tract analyses, and competitive leasing.
3. Development of detailed mining plans.

The major difference between this alternative and the proposed action is the development of detailed activity plans. These plans would be developed after completion of the RMP's and EIS's. The activity plans would also be subjected to NEPA compliance procedures.

CONCESSIONARY LEASING PROGRAM

This alternative involves a new concept in identifying areas to be leased for oil shale development. This alternative would require the same NEPA compliance procedures as discussed under the proposed action. The following four steps would be involved.

1. Identification of concession(s) - a large area of oil shale reserves. The area would be larger than the maximum lease size allowed by law.
2. Competitive sale of the concession(s).
3. Delineation of the tract(s) within concession(s). The successful bidders, after exploration, would identify the area(s) on which they wish a lease to be issued. These lease areas would be the same size or smaller than the maximum legal acreage allowed.
4. Development of a detailed mine plan.

The major difference between this alternative and the proposed action is the selling of an area larger than what would finally be leased and the identification of the area to be leased by the lessee instead of by the BLM.

DIRECT LEASING PROGRAM

This alternative would allow permanent oil shale leasing after completion of an EIS that would analyze cumulative impacts of leasing specific tracts. No codified regulations and additional land-use planning would be prepared. Leasing would be allowed under the Mineral Lands Leasing Act and existing land-use plans. The following steps would be involved.

1. Solicitation of industry leasing interests.
2. Submission of any leasing interests.
3. Delineation of potential lease tracts.
4. Preparation of a lease sale EIS.
5. Holding of a lease sale.
6. Submission of a detailed mine plan.

PROTOTYPE LEASING PROGRAM

Under this alternative, no permanent program would be developed, but the prototype program would be continued and expanded beyond its present and currently proposed lease areas. This alternative would allow further technical, economic, and environmental evaluation of oil shale development.

Energy Conservation Alternative

The Energy Conservation Alternative would involve offsetting the need for oil shale development by energy conservation (improve efficient use of available energy sources).

Alternative Energy Fuels

This alternative would offset the development of oil shale by accelerating development of other domestic sources of energy. However, only domestic sources of oil and coal are considered viable substitutions.

MAJOR ISSUES

In the scoping process and throughout the preparation of the EIS, several areas of concern related to the proposed program were identified. Results of the scoping process are documented in a report entitled Programmatic EIS Scoping Report: Federal Oil Shale Management Program (BLM 1982i), which is available for distribution from the address shown on the cover sheet of this EIS. The areas of major concern relate to potential effects on air quality, socioeconomics, quality of life, water resources, and wildlife.

Air Quality

The major issue centers upon the consumption of PSD Class I and II increments as well as general effects on Class I areas (wilderness areas, etc.).

Socioeconomics

The issues center around effects upon local housing and services resulting from increased population and employment due to oil shale leasing.

Quality of Life

The main issue is possible sociological changes to various communities within the region which could result in typical boomtown problems.

Water Resources

Water resources issues stem from possible impact of increased water consumption and salinity.

Wildlife

Issues regarding wildlife focus on possible effects on habitats and wildlife resulting from increased population and activity in the region.

MAJOR CONCLUSIONS

Table S-1 provides a summary of the key quantifiable impacts.

Proposed Action

LOW LEVEL, 2000

The proposed action for 2000 would not cause any total consumption of Prevention of Significant Deterioration (PSD) increments for any Class I or II areas. The proposed action impacts would contribute to the cumulative impacts. The worst-case impacts for Class I areas are shown in Table S-1, whereas the range of impacts for both Class I, Class II, and Colorado Category I areas are presented in Tables 3-6, 3-9, 3-12, and 3-13. The cumulative effects at the low level of development for 2000 have potential to exceed the Class I sulfur dioxide (SO_2) increment for the Flat Tops Wilderness Area in Colorado. There is potential for the cumulative concentrations to exceed the Class II TSP increment in the Buckskin Hills area in Utah and Big Duck Creek and Big Mountain areas in Colorado. There is also potential for consumption of the Colorado Category I SO_2 increments within the Dinosaur National Monument (Colorado/Utah). A potential for atmospheric deposition exists for the Flat Tops and Mount Zirkel Wilderness Areas.

The proposed action would result in a positive increase of approximately 11,300 jobs in the oil shale region over the 1980 baseline. This would add to the cumulative increase which is predicted to be approximately 105,800 jobs over the 1980 baseline. As a result of the proposed action, population is predicted to increase approximately 28,100 persons. The cumulative increase is predicted at 223,135 persons over the 1980 baseline.

Population increases associated with the proposed action would cause some stress on the communities, especially in Colorado. The cumulative population increase associated with this level would cause stress in the communities, especially in Utah. The population increases would create problems such as housing shortages, service provision shortfalls, segmentation, and increased incidents of crime, drug, and alcohol abuse, and family disturbances.

The proposed action would increase water use by 36,000 acre-feet per year over present levels for the Colorado River as measured at the inflow to Lake Powell. This would represent only a 0.5 percent reduction in flow, causing a 2 mg/l increase in salinity at Imperial Dam. The corresponding cumulative impacts would be a 164,000 acre-feet per year increase in use, a 1 percent reduction in flow and a 5 mg/l increase in salinity at Imperial Dam.

TABLE S-1

SUMMARY OF KEY IMPACTS FOR YEAR 2000

	No-Action Alternative		Proposed Action			
	Low Level	High Level	Low Level Cumulative	Low Level Federal Leasing	High Level Cumulative	High Level Federal Leasing
Air Quality Class I[a]- Flat Tops (Colorado)						
TSP (ug/m^3)	6	16	9	3	26	10
SO$_2$ (ug/m^3)	9	24	13	4	38	14
Socioeconomic						
Population (1,000)	440	490	468	28	590	100
Employment (1,000)	210	233	222	11	272	39
Water Resources Flow						
(ac-ft/yr x 1,000)[b]	-128	-304	-164	36	-368	-64
Salinity (mg/l)[c]	+3	+7	+5	+2	+10	+3
Vegetation/Wildlife Habitat						
Acres Disturbed (1,000)	140	167	148	9	195	28
Agriculture						
Acres converted to non-agricultural use (1,000)	43	54	49	6	76	22
Cultural Resources						
Sites affected at 5.4 sites/sq mi	1,178	1,409	1,250	72	1,649	240

[a] Worst-case impacts are shown; range of impacts for both Class I and Class II areas and Colorado Category I are presented in Tables 3-6, 3-9, 3-12, and 3-14.

[b] On Colorado River at inflow to Lake Powell.

[c] On Colorado River at Imperial Dam.

A flow reduction would be expected to adversely affect the endangered Colorado squawfish. Disturbance of 8,500 acres by the proposed action would affect wildlife habitat to some extent. Depending on its location, this disturbance by the proposed action is not expected to be significant. Wildlife impact from habitat disturbance by the proposed action is not expected to be as severe as the impact due to population-related increases in consumptive use, poaching, and other illegal killing or harassment (20 percent increase in Colorado and 10 percent in Utah). The cumulative impacts may be significant, since the habitat disturbance would be 148,100 acres and the consumptive and harassment increases would be 80 percent in Colorado, 122 percent in Utah, and 80 percent in Wyoming.

Impacts to developed and dispersed recreation opportunities would occur due to increased population and activity. The wilderness resource base would also experience effects from deteriorating air quality and increased use. Effects to visual resources would occur (from facilities, mines, etc.) in the Visual Resource Management (VRM) Class III and IV areas and to some extent in the VRM Class II areas (due to linear facilities). The proposed action could result in disturbance of from 13 to 72 cultural resource sites of varying significance; cumulatively, this could range from 231 to 1,250 sites.

HIGH LEVEL, 2000

The proposed action has potential for consumption of the PSD Class I TSP and SO_2 increments within Flat Tops Wilderness Area. Cumulative impact analysis also indicates a potential for consumption of the PSD Class I TSP and SO_2 increments within Flat Tops Wilderness Area and potential for consumption of the Colorado Category I SO_2 increment, within Dinosaur National Monument (Colorado/Utah).

Cumulative impact analysis results show potential for consumption of the PSD Class II TSP increment in the Buckskin Hills area in Utah and the Big Duck Creek, Big Mountain, Cottonwood Creek, and East Miller Creek areas in Colorado. In addition, potential visibility impacts would be possible for the Flat Tops Wilderness Area, Mount Zirkel Wilderness Area (Colorado) and Dinosaur National Monument. A potential for atmospheric deposition impacts exists for the Flat Tops and Mount Zirkel Wilderness Areas.

The proposed action would result in a positive increase of approximately 39,600 jobs over the 1980 baseline. This increase would result in a predicted population increase of approximately 100,200 persons over the 1980 level. The cumulative increases are predicted to be approximately 155,800 jobs and 344,700 persons over the 1980 baseline.

Most of the population increases would occur in the Colorado area, probably resulting in some service and housing shortages. It could be possible for some services to be affected beyond their current capacities.

Quality of life effects would also be felt in communities throughout the region; they would be of the same nature as the proposed action, low level, 2000, but would be of a greater magnitude, would extend further through time, and would involve more communities.

The proposed action would increase water use by 64,000 acre-feet per year over present levels for the Colorado River as measured at the inflow to Lake Powell. This would represent a 1 percent reduction in flow, causing a 3 mg/l increase in salinity at Imperial Dam. The corresponding cumulative impacts would be a 368,000 acre-feet per year increase in use, a 4 percent reduction in flow and a 10 mg/l increase in salinity.

The predicted flow reduction would be expected to adversely affect the endangered Colorado squawfish. Disturbance of approximately 28,400 acres by the proposed action would affect, to some degree, wildlife habitat. Depending on its location, this impact could be significant. Impact from habitat disturbance is not expected to be as severe as impact from increased population or consumptive use and harassment of wildlife. The proposed action is predicted to increase this type of impact by 70 percent in Colorado, 20 percent in Utah, and 14 percent in Wyoming. The cumulative impacts are expected to be significant, with disturbance of 195,400 acres and increases in consumptive uses and harassment of wildlife of 152 percent in Colorado, 173 percent in Utah, and 94 percent in Wyoming.

As a result of the population increase from the proposed action, a conversion of approximately 22,000 acres of agricultural land to urban uses is predicted. This represents a 2 percent loss of the total agricultural land in the oil shale region. The cumulative impact would be approximately 75,800 acres or a 10 percent loss. The loss at the cumulative level would constitute an important change because of the limited supply of these lands.

Demand for dispersed and developed recreation opportunities would increase and impacts would occur due to crowding, competition for favored sites, lack of game animals to hunt, and deterioration of air quality. As a result of population increases and effects on air quality, appreciable effects would occur to regional wilderness areas and wilderness experiences for users. Impacts would also occur to visual resources in the area, especially in the VRM Class III and IV areas and, to some extent, in the VRM Class II areas due to linear facilities. The proposed action could result in the disturbance of from 44 to 240 cultural sites of varying significance; the cumulative total could range from 305 to 1,649 sites.

No-Action Alternative

LOW LEVEL, 2000

Potential air quality impacts could occur within the Class I Flat Tops Wilderness Area (potential for SO_2 increment consumption) and to the Class II areas at Buckskin Hills area in Utah and the Big Duck Creek and Big Mountain areas in Colorado (where the potential for PSD Class II TSP increment consumption exists). The analysis also shows a potential for consumption of the Colorado Category I SO_2 increment within Dinosaur National Monument.

Population would increase by approximately 195,000 persons and employment would increase by approximately 94,500 jobs over 1980 levels. Housing and services shortages could be possible but would be generally insignificant. Effects to the quality of life in the region would generally be a moderate level of change, with the communities within Utah experiencing substantial changes, similar to those discussed under proposed action, low level, 2000.

This alternative would result in an increase of approximately 128,000 acre-feet per year beyond present use levels for the Colorado River, representing a decrease in flow of about 1 percent. This would result in a salinity increase of 3 mg/l at Imperial Dam.

A total of about 139,000 acres would be disturbed. Impacts to vegetation would be insignificant when compared to the total region. About 5.9 percent (42,900 acres) of agricultural land would be lost. Impacts to wildlife would occur due to increased population and use pressure. Some effects would occur to the wilderness resource due to more people and potentially deteriorating air quality. Impacts would occur to visual resources in the area, specifically in the VRM Class III and IV areas, and some VRM Class II areas because of linear facilities. The potential exists for affecting from 218 to 1,178 cultural resource sites of varying significance.

HIGH LEVEL, 2000

Development at this level would have the potential for consuming PSD Class I TSP and SO_2 increments at the Flat Tops Wilderness Area. Potential exists for consumption of the Colorado Category I SO_2 increment within Dinosaur National Monument. Potential PSD Class II TSP increment consumption is projected for Buckskin Hills area in Utah and the Big Duck Creek, Big Mountain, and Cottonwood Creek areas in Colorado

Population would increase by approximately 244,500 persons and employment would increase by 116,900 jobs over 1980, which could create housing and service shortages. Extensive social changes would be expected to occur to communities in the region, especially in Utah, creating similar effects to those discussed for proposed action, low level, 2000.

Water use would increase 304,000 acre-feet, causing a flow depletion of 3 percent in the Colorado River (at the inflow to Lake Powell). This flow reduction would result in a salinity increase of 7 mg/l at Imperial Dam.

Flow reductions would be expected to adversely affect the endangered Colorado squawfish. A total of 167,000 acres would be disturbed. Effects to vegetation, agricultural and grazing land, and wildlife habitat would occur. Approximately 53,800 acres of pasture and cropland would be converted to urban uses (7.4 percent of the regional base). Due to more people and activity in the area, impacts to wildlife could be important due to increased consumptive and non-consumptive uses, illegal killing and poaching, and harassment. These increases are predicted to be 82 percent in Colorado, 153 percent in Utah, and 90 percent in Wyoming.

Demand upon and impacts to developed and dispersed recreation opportunities would increase. Effects to wilderness resources such as increased use pressure and air quality deterioration would also occur. An undetermined amount of impact to visual resources would occur in VRM Class III and IV areas, with some changes being caused by the introduction of linear systems in VRM Class II areas. Under this level, there is the potential for disturbance of between 312 to 1,586 cultural resource sites.

Program Alternatives

ACTIVITY PLANNING PROGRAM, CONCESSIONARY LEASING PROGRAM, AND DIRECT LEASING PROGRAM

Although there are some differences between these alternatives and the proposed action in determining and issuing leases, the degree of impact would be related to the level of leasing which occurs. Therefore, it was assumed for this analysis that the impacts would fall within the same range of impacts as predicted for the proposed action and No-Action Alternative. All leasing under each of these alternatives would be preceded by planning and site-specific NEPA review and compliance.

It is recognized that in the concessionary approach, there would be a larger area initially committed to oil shale exploration and lease selection. This would create a potential for surface impacts from exploration over a larger area than the proposed program. Since the Direct Leasing Alternative relies on existing land-use plans, without additional land-use or activity planning, the ability to project and plan for impacts is dependent upon the adequacy of the information base in the existing land-use plans.

PROTOTYPE LEASING PROGRAM

The impacts of a prototype leasing program would directly relate to the degree of prototype leasing. Depending upon the level of leasing, impacts would be similar to the No-Action Alternative levels, to those impacts addressed in the prototype supplemental EIS (BLM 1982h), or the proposed action levels.

Energy Conservation Alternative

If this alternative were implemented, the impacts from energy resource development (oil shale) would be reduced from those impacts associated with oil shale development under the No-Action Alternative or the proposed action.

Alternative Energy Fuels

The development of oil and synthetic fuel from coal to offset oil shale needs would each create some impacts. Domestic oil development would require less land disturbance. Coal development would have the potential for creating more air quality impacts than oil shale development. Several large oil fields (30 to 50 wells) would be required to equal the production which could occur under the proposed action. Mining of from 10 to 40 million tons of coal annually would be required. A number of conversion plants would be needed which would cause the attendant air quality, socioeconomic, and water use impacts.

ISSUES TO BE RESOLVED

Due to the broad scope of this EIS, many issues remain to be resolved through further analyses. The majority of effects to various resources (wildlife, vegetation, socioeconomics, etc.) remain to be resolved through mitigation developed at the land-use planning, environmental analyses stage.

Effects to air quality in the region from oil shale development will require additional detailed site-specific analysis to determine if the impacts can be resolved. Given specific information on location, emission rates, and control technology, impacts may be smaller. As indicated by the analysis in this EIS, a potential exists for conflict with the existing air quality regulations.

CHAPTER 1

DESCRIPTION OF PROPOSED ACTION AND ALTERNATIVES

INTRODUCTION

The proposed action is the adoption of a program to manage leasing of federal oil shale resources. Program adoption would result in a set of codified regulations, which would establish both the procedures to determine the need for leasing and the means by which the Bureau of Land Management (BLM) and the Department of the Interior (DOI) would lease.

Purpose and Need of Proposed Action

The purpose is to effectively and efficiently lease oil shale, if and when a need for leasing is determined. This proposed action does not address the need for oil shale leasing, rather it establishes procedures to determine the location, schedule, and stipulations for federal oil shale leases.

Oil shale represents a vast, untapped domestic energy resource, the majority of which, including the highest yield deposits, is located on public lands. The United States does not have a way to plan, lease, and develop this resource in an orderly fashion. The federal government must be prepared to lease and to allow development of federal oil shale, in light of the continuing demands for domestic and worldwide energy, continuing shrinkage of the finite domestic and worldwide fossil fuels, and national security's reliance on dependable energy supplies.

Location of the Proposed Action

The oil shale region analyzed in this Environmental Impact Statement (EIS) encompasses potential federal oil shale leasing areas in northwestern and north-central Colorado, northeastern Utah, and southwestern Wyoming. The directly affected counties would be Carbon, Lincoln, Sublette, Sweetwater, and Uinta (Wyoming); Carbon, Duchesne, Grand, and Uintah (Utah); and Garfield, Mesa, and Rio Blanco (Colorado). The Uintah and Ouray Indian Reservation in Utah would also be directly affected. For additional detail on this area refer to Chapter 2 and Map 2-1.

Authorizing Actions

The authorization of the proposed action is not a decision to lease. Rather, adopting the proposed action (or an alternative program) would establish the procedures to determine the potential sites and timing of leasing that may be necessary or undertaken.

Interrelationships

This section addresses the relationship of the proposed action to existing and pending legislation, land-use planning, the oil shale prototype leasing program, private shale development, oil shale exchanges, and oil shale mining claims.

A program for long-term oil shale leasing is being proposed according to the oil shale leasing authority of the Mineral Lands Leasing Act of 1920, as amended and supplemented (30 USC 181 **et seq.**). Under the proposed action, policy and procedures for this existing Departmental authority would be established in codified regulations. The oil shale industry, the public, and all relevant levels of government could thus understand long-term program direction through comprehensive regulations.

The adoption of oil shale program regulations is not dependent on the passage of oil shale legislation which is presently pending in the U.S. Congress, since the Department already has existing oil shale management and leasing authority. However, if any of the pending bills becomes law, it could influence the means in which the Department implements an oil shale program, or it could require revisions to some portions of the regulations. None of the pending bills, however, would be specific enough to require an extensive revision of the proposed program regulations. The Department is thus proceeding to analyze adoption of a proposed program which would establish procedures under existing oil shale management authority rather than waiting on future legislation which may or may not become law.

All of the program alternatives contained in this EIS would rely heavily on land-use planning. Therefore, any proposed regulations would address land-use planning procedures and policies in accordance with the Federal Land Policy and Management Act of 1976 (FLPMA). Under the proposed program the major land-use planning procedures specific to oil shale would include multiple-use resource analyses to identify areas and specific tracts acceptable for oil shale leasing.

The land-use planning process would also serve to identify site-specific environmental impacts for oil shale lease sales under the proposed program. This would be done through a Resource Management Plan (RMP), which is a land-use plan prepared by BLM and required by regulation (43 CFR 1600) to be accompanied by an EIS. The RMP EIS would address the cumulative and site-specific impacts of leasing various tract combinations. Accordingly, the NEPA requirements for lease sales would be consolidated with the NEPA requirements for the RMP. Furthermore, the RMP EIS would address on-the-ground impacts which are beyond the scope of this EIS, but which could occur from implementation of the proposed program.

The oil shale prototype is designed to offer leases in order to:

1. Provide a new source of energy to the Nation by stimulating the development of commercial oil shale technology by private industry;

2. ensure the environmental integrity of the affected areas and at the same time develop a full range of environmental safeguards and restoration techniques that may be incorporated into a mature oil shale industry;
3. permit an equitable return to all parties in the development of this resource; and
4. develop management expertise in the leasing and supervision of oil shale development in order to provide the basis for future administrative procedures.

The prototype program differs from the proposed permanent program, because it does not establish a mechanism for the long-term management of future federal oil shale leasing and development.

To date, the prototype program has resulted in four leases. Two tracts in Colorado and two in Utah were leased in 1974, but none has resulted in commercial production. Initial facility construction and limited shale oil production, however, has been conducted on both Colorado tracts. Groundbreaking on the two Utah tracts is planned, but has yet to occur.

Simultaneously, but independent of the development of this proposed action, the Department is considering issuing as many as two more prototype leases in Colorado. The site-specific impacts of that action are being addressed in a separate EIS, which will supplement the original 1973 EIS. The primary purpose of the supplement is to evaluate the impacts of offering and leasing as many as two additional tracts.

Many oil shale projects on private property cannot be developed without the use of nearby federal lands for facilities (i.e., rights-of-way locations and reservoirs). In accordance with FLPMA, procedures already exist for the leasing or selling of such lands. Similar actions have already taken place and others are under consideration by BLM independent of this proposed action. Accordingly, the proposed action would not pursue any such procedures but, rather, would rely on existing procedures.

In the areas of land exchanges for oil shale and mining claim adjudication, the proposed action would rely on existing regulations or future changes to such regulations. Exchange regulations allow the federal government to exchange fee or other title interests with private parties or state entities. Mining claim law and regulations specify procedures for BLM to process existing mining claims in order to determine eligibility for patent.

HISTORY AND BACKGROUND OF OIL SHALE LEASING

A brief history of oil shale development is presented in Appendix 3.

INTRODUCTION-HISTORY AND BACKGROUND

Federal Leasing Program to Date

During World War II, the passage of the 1944 Synthetic Fuels Act was spurred by a shortage of domestic oil resources due to military needs. This legislation awarded research and development money to the U.S. Bureau of Mines to construct and operate a pilot oil shale mine at Anvil Points, Colorado (Naval Oil Shale Reserve No. 3, southern edge). Under the authority of an act passed on October 11, 1962 (76 Stat. 904.10, USC 7438), the Anvil Points facility was leased to two energy groups for further experimentation.

In 1968, the Secretary of the Interior attempted to initiate an experimental leasing program to stimulate private industrial development of federal oil shale lands in the Green River Formation. No leases resulted from this attempt, even though oil shale leases were offered.

During the early 1970's, an oil shale task force was established within the Department of the Interior to evaluate the prospects for oil shale development and to devise a limited oil shale leasing program. The final product of the task force was the Prototype Oil Shale Leasing Program of 1974. (See The Prototype Oil Shale Leasing Program EIS, BLM 1973.) The 1973 EIS provides a background on the purpose, issues, and intent of the prototype program. Two tracts were offered for lease in each of the states in the Green River Formation (see Figure 1-1). Table 1-1 presents the results of the 1974 prototype sale.

BLM is presently proposing a second round of leasing under the prototype program. The proposal is being assessed in a supplement to the final EIS for the Prototype Oil Shale Leasing Program. The draft supplemental environmental impact statement has been released (BLM 1982h). The final supplemental EIS was released to the public in January 1983. The proposed tracts are in Colorado (see Figure 1-1), and the projected date of the prototype lease sale is March 31, 1983.

State Leasing Programs to Date

The State of Utah owns 6 percent of the oil shale reserves in the Uinta Basin within Utah, and the State of Wyoming owns 6 percent of the reserves in the Washakie and Green River basins; the State of Colorado owns only a few isolated oil shale tracts.

Of the three states, only Utah has leased oil shale lands (see Table 1-2). Detailed information on the specific technologies to be used by five companies, the environmental impacts, and the expected production levels is provided in the draft Uintah Basin Synfuels Development EIS (BLM 1982g).

Indian Reservation Leasing Programs to Date

The Uintah and Ouray (U and O) Indian Reservation owns 8 percent of the surface and some mineral rights to oil shale lands within the Uinta Basin in Utah. Consequently, the actual Uintah and Ouray oil shale holdings are less

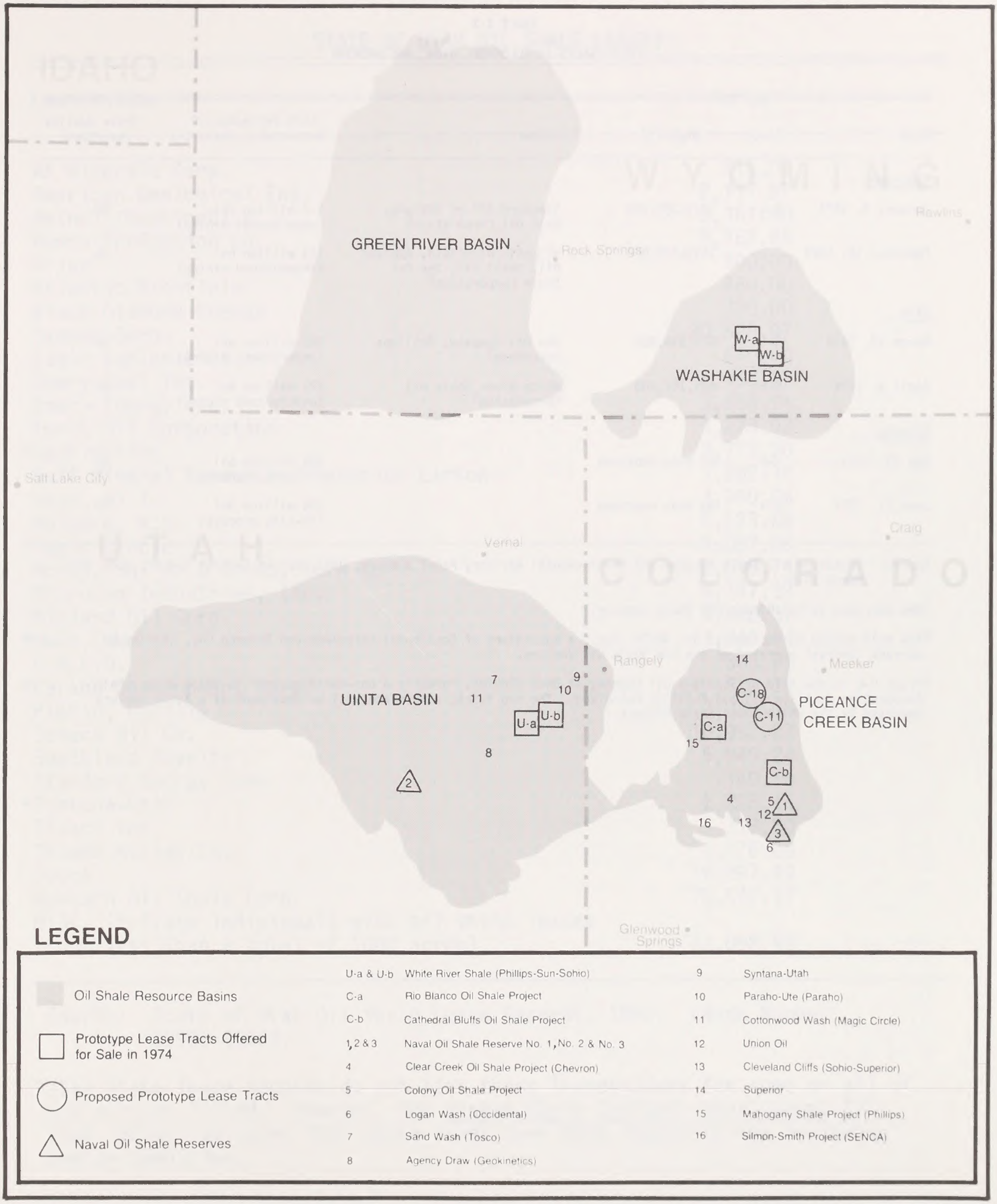

IDAHO
WYOMING
Rawlins
GREEN RIVER BASIN
Rock Springs
W-a
W-b
WASHAKIE BASIN
Salt Lake City
UTAH
Vernal
Craig
COLORADO
Rangely
Meeker
14
7
9
10
11
UINTA BASIN
U-a
U-b
C-18
C-11
PICEANCE CREEK BASIN
C-a
15
8
2
C-b
4
5
1
12
16
13
3
6
Glenwood Springs
LEGEND
Oil Shale Resource Basins
Prototype Lease Tracts Offered for Sale in 1974
Proposed Prototype Lease Tracts
Naval Oil Shale Reserves
U-a & U-b White River Shale (Phillips-Sun-Sohio)
C-a Rio Blanco Oil Shale Project
C-b Cathedral Bluffs Oil Shale Project
1, 2 & 3 Naval Oil Shale Reserve No. 1, No. 2 & No. 3
4 Clear Creek Oil Shale Project (Chevron)
5 Colony Oil Shale Project
6 Logan Wash (Occidental)
7 Sand Wash (Tosco)
8 Agency Draw (Geokinetics)
9 Syntana-Utah
10 Paraho-Ute (Paraho)
11 Cottonwood Wash (Magic Circle)
12 Union Oil
13 Cleveland Cliffs (Sohio-Superior)
14 Superior
15 Mahogany Shale Project (Phillips)
16 Silmon-Smith Project (SENCA)

FIGURE 1-1 OIL SHALE LEASES WITHIN OIL SHALE REGION

TABLE 1-1

LEASE SALES IN COLORADO, UTAH, AND WYOMING

Date	Tract	High Bid	Bidder	1973 Estimates of Recoverable Shale Oil	Shale Quality (gal/tons)
Colorado					
January 8, 1974	C-a	$210,305,600	Standard Oil of Indiana, Gulf Oil Corporation[1]	1.3 billion bbl (underground mining)	30
February 12, 1974	C-b	$117,778,000	Atlantic Richfield, Ashland Oil, Shell Oil, The Oil Shale Corporation[2]	723 million bbl (underground mining)	30
Utah					
March 12, 1974	U-a	$75,596,800	Sun Oil Company, Phillips Petroleum[3]	331 million bbl (underground mining)	30
April 9, 1974	U-b	$45,107,200	White River Shale Oil Corporation[3]	271 million bbl (underground mining)	30
Wyoming					
May 13, 1974	W-a	No bids received		354 million bbl (in-situ process)	20
June 11, 1974	W-b	No bids received		352 million bbl (in-situ process)	20

Source: Prototype Oil Shale Program and Environmental Advisory Panel Summary, USDI, Denver Federal Center, Bldg. 67, March 1979.

[1] Now operated as Rio Blanco Oil Shale Company.

[2] Now held solely by Occidental Oil Shale, Inc., a subsidiary of Occidental Petroleum and Tenneco Co., sharing 50 percent interest operated as the C-b Shale Oil Venture.

[3] Tract U-b is now held by Standard Oil Company of Ohio (SOHIO), formerly a one-third partner in White River Shale Corporation with Sun Oil and Phillips Petroleum. The two tracts adjoin and will be developed as a joint venture operated as the White River Shale Project.

TABLE 1-2

STATE OF UTAH OIL SHALE LEASES

Leaseholder	Acres
AA Minerals Corp.	215.00
American Geological Ent.	2,117.97
Aminoil/Geokinetics	6,361.90
Amoco Production Co.	9,362.84
Arjay	400.00
Atlantic Richfield	480.00
Black Diamond Energy	720.00
Cayman Corp.	20,528.97
Eagle Exploration	640.00
Emery Coal Inc.	4,962.07
Emery Energy Inc.	3,686.94
Forst Oil Corporation	1,279.92
*Geokinetics	3,772.20
Gulf Mineral Resources/Frederick Larson	1,282.12
Hays, Al T.	3,940.06
Holberg, R.S.	5,623.69
*Magic Circle	5,087.66
McVey, Hal A. & Jones, Kern K.	6,030.74
Microton Industries, Inc.	8,747.32
Midland Oil Corp.	4,468.37
*Moon Lake	1,344.74
O.A.C.O.	303.80
*Paraho Development Corp.	622.30
Pipkin, Lucille	2,080.00
Seneca Oil Co.	10,982.22
Southland Royalty	5,949.24
Standard Energy Corp.	160.10
*Syntana-Utah	1,225.15
Texaco Inc.	717.50
Toledo Mining Co.	1,276.00
Tosco	19,297.49
Western Oil Shale Corp.	70,547.17
MISC. (Private individuals with oil shale leases less than a total of 1000 acres)	11,098.98

Source: State of Utah Oil Shale Lease Records. 1982. Lease Number 13986-39765.

*Utah State lease records do not list these leaseholders for some or all of the acreage listed. However, the Uintah Basin Synfuels Development EIS (BLM 1982g) indicates that these lands have been leased to the following energy companies.

than 8 percent, as the U and O Indian Reservation has substantial surface ownership in the Hill Creek Extension area, but the majority of the mineral rights are owned by the federal government. Presently, none of the shale oil reserves has been leased or commercially developed.

The Wind River Tribe in Wyoming, the Ute Mountain Reservation in Colorado, and the Southern Ute Reservation in Colorado own no oil shale reserves.

Naval Oil Shale Reserves

President Wilson created the Naval Oil Shale Reserve (which includes 27,000 acres within the western oil shale region) on December 16, 1916, to ensure national defense would not be jeopardized by a short supply of domestic oil reserves. In 1924, President Coolidge added 23,000 acres to the Naval Oil Shale Reserves in Colorado and 4,880 acres to the Utah Naval Oil Shale Reserve.

The richest of the oil shale reserves is Naval Oil Shale Reserve No. 1 located in Garfield County, Colorado, with an estimated 6 billion barrels of greater than 25 gal/ton of oil shale. Naval Oil Shale Reserve No. 3 (also in Garfield County) has no oil shale resources but is a probable site for disposal. Naval Oil Shale Reserve No. 2 in Carbon and Uintah counties in Utah contains approximately 3.8 billion barrels of total reserves and 0.8 billion barrels of greater than 30 gal/ton of oil shale. Today, the Department of Energy (DOE) manages the Naval Oil Shale Reserves. In 1980 they selected a no-development option on the Draft Development Policy Options, Naval Oil Shale Reserves, Garfield County, Colorado, EIS (DOE 1980).

Private Developments to Date

Oil shale has been perceived historically as a substitute to a diminishing energy resource. The oil shale industry has undergone three major waves of interest:

(1) Mid-1800's - - - Oil shale was predicted to be a substitute for wood. An oil shale plant located on the Ohio River produced 30 gal/day of shale oil. Other small plants supplied the United States eastern seaboard with fuel. In Titusville, Pennsylvania, in 1859, petroleum discoveries introduced a cheaper fuel source, and interest in oil shale waned.

(2) 1915-1930 - - - This was triggered by an impending shortage of petroleum, the increased use of the automobile, and the discovery of huge oil shale reserves in the West. Primary activity during this period occurred in the Green River Formation area. The major stumbling blocks to developing an oil shale industry were new discoveries of petroleum; a lack of technical knowledge of mining, retorting, and refining methods; insufficient return on investment; and transportation difficulties.

The only enterprise that produced significant quantities of shale oil was Catlin Oil Products of Elko, Nevada. Although Catlin Oil Products was an unsuccessful financial venture, Robert Catlin did market his shale oil and kept his plant in operation for approximately 4 years.

(3) 1950 to present - - - There has not been any commerical production of shale oil since Catlin Shale Products. Appendix 3 shows that private industry has been primarily involved with research and development. Since the 1970's, DOE has played an active role in encouraging the development of oil shale by working in conjunction with private shale oil companies and furnishing financial supports. Appendix 3 indicates that private industry is steadily progressing toward commercial development.

Private ownership of oil shale reserves is 21 percent in Colorado, 17 percent in Wyoming, and 9 percent in Utah. This ownership stems from lands placed under claim prior to 1920 and from the original homesteads; the majority of these private mining claims have since been acquired by oil companies.

PROPOSED ACTION

The action being proposed is the establishment of a permanent oil shale management program with codified regulations. The adoption of this program would establish a procedure to plan and lease federal oil shale, if and when necessary. The proposed program would rely on RMP's to identify potential oil shale lease tracts within areas which are acceptable for oil shale development; other key provisions are public/state consultation through a Regional Oil Shale Team (ROST); a competitive leasing system which assures a return to the government based upon fair market values; and provisions for diligence, royalty rates, rentals, lease terms, lease modifications, lease transfers, and lease cancellations. The remainder of this section provides a chronological overview of how the proposed procedures would work, if adopted. The actual procedures are detailed in the proposed regulations which are incorporated by reference into this EIS.

The first phase of program implementation would be the publication of RMP's with resultant EIS's by September 1984, in Utah (Bookcliffs Area) and Colorado (Piceance Basin), and by 1988, in Wyoming. These RMP's would identify various federal land uses (e.g., grazing, coal, wildlife, etc.) based on multiple use principles. From the oil shale perspective, RMP's would identify areas within which oil shale development would be generally acceptable, as well as identify specific tracts within these oil shale priority use areas (areas which could be leased).

In order to identify oil shale priority use areas within the RMP, BLM would solicit public input on the oil shale reserve values at the beginning of the planning effort. At the same time, other mineral information (e.g., sand and gravel, tar sand, oil and gas, and coal) would also be requested. For oil shale, the information would be acquired through Minerals Management Service's (MMS) geologic data on oil shale, public expressions of interest, ROST meetings, as well as the standard RMP public input processes. This would include continuous information exchange with industry and the public. The nature of the oil shale reserves would then be determined based on this input. Potential oil shale reserve development would then be evaluated in light of other potential land uses so that areas of compatible and conflicting land uses could be identified.

After oil shale priority use areas are defined, but prior to the draft EIS on the RMP, BLM would provide the public an opportunity to express interest for or against oil shale leasing. BLM and MMS, with the ROST's assistance, would then delineate potential oil shale lease tracts and appropriate supporting ancillary facilities which could then be analyzed within alternative priority use areas. The analysis would include site-specific evaluations of environmental and socioeconomic effects of potential lease tracts development and also include cumulative impact projections on the development of alternative areas. At the completion of the RMP EIS, BLM would confirm the location of the priority use areas for oil shale development. Within these use areas would be potential lease tracts which have been analyzed to the extent that leasing could follow (with no further National Environmental Policy Act (NEPA) or FLPMA analysis). Where appropriate, opportunities for impact mitigation would also be identified in the RMP.

Other potential oil shale operations which may be identified through the RMP process include off-site disposal areas (if authorized by future legislation), ancillary rights-of-way (transportation and utilities) and reservoirs, and community infrastructure facilities on federal lands. Where information is sufficient, decisions on ancillary facilities within the RMP area may then be made concurrently upon RMP completion.

After completion of the RMP, the ROST would recommend the specific tract(s) for competitive leasing based on demand for oil shale; a balance among national, state and local interests; environmental impacts (including socioeconomics); and the state of the industry (i.e., technological or economical viability). The Secretary of the Interior would then decide which tracts, if any, to lease based on these same criteria, the ROST recommendation, and formal consultation with the governor of the state in which leasing would occur. If the Secretary decides to lease one or more tracts, sale procedures and lease terms (including lease stipulations, diligence requirements, royalty payments, and bidding procedures) would be announced at least 30 days in advance via Federal Register notice. The appropriate BLM state director(s) would then conduct a competitive lease sale.

Subsequent lease sales could recur annually, provided the sales are consistent with the cumulative impacts and multiple use findings of the RMP plan. If so, the only subsequent analysis would be another tract-specific call for expressions of interest, another public ROST lease sale evaluation and recommendation, a Secretarial decision and a BLM competitive sale. It should be realized that the exact boundaries of the tracts originally analyzed in the RMP could be redelineated without further detailed analysis, provided that the tracts are still within the oil shale priority use areas of the RMP and the impacts consistent with that of the RMP and EIS. Furthermore, additional lease tracts can be delineated and offered with appropriate NEPA compliance, if the new tracts are within the RMP's oil shale priority use areas and if the cumulative impacts analysis of the RMP and EIS is not exceeded.

After the lease sale, BLM would issue the lease to the high bidder, provided that bidder passes qualification evaluations and agrees to all lease terms and payments. Upon lease award, the lessee would be required to apply for and gain approval of an oil shale mining and development plan. Oil shale development could commence upon MMS's approval of such a plan in accordance with 30 CFR 231.

Legal Context for Program

THE MINERAL LANDS LEASING ACT OF 1920

Prior to 1920, oil shale was a locatable mineral under the general mining laws. On February 25, 1920, the Mineral Lands Leasing Act (MLLA) withdrew from location oil shale and certain other minerals on the Public Lands listed under the mining law and provided that those minerals could henceforth be disposed of only through leasing under the MLLA. It also provided a "savings clause" for valid mining claims in existence on February 25, 1920, if those claims were maintained in compliance with the general mining laws. Section 21 of the Act authorizes the Secretary of the Interior, under such rules and regulations as prescribed, to lease federal oil shale deposits, the surface of land containing such deposits, and adjacent land as required for extraction and reduction (processing) of the leased minerals. The act places a limit of one oil shale lease per person, association, or corporation. No lease may exceed 5,120 acres. The terms and conditions of leases under Section 21 are left to the discretion of the Secretary, who can impose covenants in leases, including those relating to methods of mining, waste prevention, and productive development.

The statutory limitation of one lease per person, association, or corporation gives the Secretary no authority to issue additional federal leases for off-site processing of shale or for disposal of spent oil shale. Specifically, Section 701(d) of FLPMA prohibits off-lease disposal of spent oil shale on federal lands. Moreover, the acreage limitation of 5,120 acres per lease restricts the scale of development. Persons holding valid claims to oil shale under the general mining law as of January 1, 1919, are entitled to a lease under the MLLA for acreage equal to the amount relinquished, not to exceed 5,120 acres.

Revenues (bonus payments, rentals, or royalties) from federal oil shale leases are distributed according to Section 35 of the MLLA, which provides that 50 percent of all revenues are to be paid to the state where the leased lands are located. States may use the funds, as their legislatures direct, for planning, construction of public facilities, and provision of public services, with priority to subdivisions socially or economically affected by oil shale development.

In 1920, the Department issued regulations to provide for the issuance of noncompetitive oil shale leases. These regulations, including a form lease, were substantially unchanged until 1968, when they were revoked. (No leases were issued under these regulations.) In 1930, Executive Order No. 5327 withdrew federal oil shale deposits and lands from lease or other disposal. In order to lease the tracts selected for the 1974 prototype oil shale leasing program, the Department modified Order No. 5327 to exclude those selected tracts.

Although the Department published leasing procedures and the prototype oil shale lease in the Federal Register, no regulations for the prototype program were codified.

COURT DECISIONS

All four of the oil shale leases issued in the prototype program have been the subject of litigation. The Department's approval of detailed development plans for Colorado leases C-a and C-b was challenged in Environmental Defense Fund, Inc., vs. Andrus, 619 F.2d 1368 (10th Cir. 1980). The Court of Appeals held that the detailed development plans submitted by the lessees, which were modified in 1977, did not demonstrate any significant environmental impacts which were not adequately identified and described in the 1973 EIS prepared in connection with the prototype program (BLM 1973). Therefore, the court ruled that supplemental EIS's were not required for the Secretary to approve detailed development plans which called for modified in-situ processing, a concept not specifically addressed in the 1973 EIS.

In Utah, the terms and conditions (including the lessees' obligation to pay the fourth and fifth installment of the bonus payments) of oil shale leases U-a and U-b were suspended by a court injunction in 1977. The injunction was requested by the lessees to relieve them from their lease obligations during the pendency of other litigation potentially affecting their leasehold estate. The major case involved the claim by the State of Utah that it was entitled to select federal lands, including those covered by leases U-a and U-b, in lieu of original school land grants. The Supreme Court rejected this claim in 1980, and monies from rental and bonus payments on U-a and U-b, which had been impounded by the District Court, were released in January 1982. Additional litigation brought by the lessees involved claims that the United States did not have good title to the leased lands. However, pursuant to the lessees' motion, the injunction against development was dissolved on March 2, 1982, and development of the tracts could commence soon.

OTHER LEGAL CONSTRAINTS

Numerous other laws regulate certain aspects of oil shale leasing (see Table 1-3). The Mineral Leasing Act for Acquired Lands governs leasing on federally acquired lands for oil shale as well as other minerals. The Act requires the consent of the head of the federal agency having administrative jurisdiction over the lands before BLM can lease the oil shale. Otherwise, the leasing provisions are the same as those for Public Lands under the MLLA.

TABLE 1-3

FEDERAL LAWS AFFECTING OIL SHALE DEVELOPMENT

Popular Name	Public Law/U.S. Code Citation	Purpose/Requirements	Major Relevance
Antiquities Act of 1906	59-209; 16 U.S.C. 431-433	Regulates antiquities excavation and collection on lands under Secretary of Interior's jurisdiction	Mitigates potential harm to historical and archaeological resources
		Protects historic monuments and ruins on Public Lands	
Archaeological and Historical Preservation Act of 1974; Archaeological Salvage Act	93-291, 86-523; 16 U.S.C. 469	Provides for recovery of data from areas to be affected by federal actions, including federally licensed projects	Mitigates potential harm to historical, archaeological, and paleontological resources
		Provides for preservation of data (including relics and specimens) at every federal construction project and federally licensed project	Mitigates potential harm to historical and archaeological resources
Archaeological Resources Protection Act of 1979	96-95	Protects archaeological resources by regulating excavation and collection on Public and Indian lands	Mitigates potential harm to historical and archaeological resources
Bald Eagle Protection Act of 1969, as amended	86-70; 16 U.S.C. 668	Protects bald and golden eagles	May require certain limitations on development
Clean Air Act Amendments of 1977	95-95; 42 U.S.C. 7401	Establishes requirements for areas failing to attain National Ambient Air Quality Standards (NAAQS)	Limits industrial development within and adjacent to areas exceeding NAAQS and areas preserving clean air quality
		Provides for prevention of significant deterioration of areas where air is cleaner than NAAQS	
		Modifies 1970 Clean Air Act provisions regarding federal facilities, enforcement strategies, and interstate air pollution	
Clean Water Act of 1977	95-217; 33 U.S.C. 1251	Establishes effluent limitation for new and existing industrial discharge into U.S. waters	May reduce development options if antidegradation policy restricts discharges into high quality waters
		Provides mechanism to restore and maintain integrity of the Nation's waters	Treatment facilities in areas with rapidly expanding infrastructures must meet water quality standards
Endangered Species Act of 1973, as amended	93-205; 16 U.S.C. 1531	Protects endangered and threatened species and critical habitat from federal activities	Requires prior consultation with Fish and Wildlife Service
Fish and Wildife Coordination Act of 1934, as amended	85-624; 16 U.S.C. 661	Requires consultation about water resource development actions which might affect fish or associated wildlife resource	Mitigates potential federal oil shale development impacts
Historic Preservation Act of 1966	89-665; 16 U.S.C. 470	Establishes system to classify properties on or eligible for inclusion on Historic Register	Mitigates potential harm to historical and archaeological values
		Mandates federal agency consultation with Advisory Council and State Historic Preservation Officers	
Migratory Bird Treaty Act of 1941, as amended	16 U.S.C. 701-718h	Protects migrating birds not covered by other federal laws	Provides legislation to purchase areas for refuges and to provide for migratory bird conservation

TABLE 1-3 (cont'd)

EEDERAL LAWS AFFECTING OIL SHALE DEVELOPMENT

Popular Name	Public Law/U.S. Code Citation	Purpose/Requirements	Major Relevance
National Environmental Policy Act of 1969 (NEPA)	91-190; 42 U.S.C. 4321	Encourages productivity and harmony between man and his environment; ensures that environmental values are considered in decisionmaking; makes environment protection a duty of every federal agency	Provides legislative mandate to consider environmental review of major federal action in energy development
		Requires impact statements for major federal actions with potentially significant impacts	Impact statement process must be integral part of oil shale leasing system
Resource Conservation and Recovery Act of 1976	94-580; 42 U.S.C. 6901, as amended	Establishes guidelines for collection, transport, separation, recovery and disposal of solid waste	Mining locations may be affected by EPA regulations governing disposal of oil shale mining wastes
		Creates major federal hazardous waste regulatory program	Industry may have stringent permit requirements if wastes classified by EPA are hazardous
		Provides assistance to establish state or regional solid waste plans	
Safe Drinking Water Act of 1977	95-190; 42 U.S.C. 300f-j	Protects water quality; sets national standards	Requires states (or EPA) to regulate harmful injections which endanger public drinking water system

Source: BLM, Washington Office, Branch of Tar Sands and Oil Shale, 1982.

PROPOSED ACTION-MITIGATION INCLUDED

The FLPMA provides BLM with a statutory framework for developing land use plans for the Public Lands. When BLM has developed land use plans for an area, subsequent uses of the area may not be inconsistent with the plan. Section 206 of FLPMA also provides authority for exchanging tracts of federal land for non-federal lands. Section 701(d) of the Act provides that FLPMA shall not be construed to permit the Secretary to authorize placement of spent oil shale on any Public Land other than land leased for recovery of oil shale under Section 21 of the MLLA. Title V of FLPMA authorizes the Secretary to grant rights-of-way over Public Lands for roads, transmission lines, reservoirs, and other facilities.

There are 2,260 unpatented oil shale mining claims recorded under FLPMA (Section 314), covering 360,525 acres in Colorado, Utah, and Wyoming. Since 1960, litigation over these unpatented claims has resulted in two Supreme Court decisions on the issue of the discovery and assessment work necessary for issuance of patents for oil shale mining claims. The correctness of the Department's interpretation and application of the Supreme Court cases is currently before the U.S. District Court in Colorado, and final judicial resolution of the cases may not occur for many years. Patenting the disputed mining claims could indirectly affect the need for additional leasing and would also reduce the amount of land available for inclusion in the proposed leasing program; however, lands encumbered by unpatented claims would not be included in tracts to be considered suitable for leasing until they are free of any encumbrances.

State law dictates the manner in which water rights may be established, and the mechanisms created by these states are unique to each. Colorado, Utah, and Wyoming utilize the Appropriation Doctrine as the cornerstone of their water rights systems. Within limits, the water rights are "freely alienable" (capable of being transferred to the ownership of another) commodities available at a price to anyone sufficiently interested to pay. Therefore, this EIS assumes that water rights necessary for development may be acquired on the open market.

Mitigation Included in Proposed Action

The design of the proposed oil shale leasing program would provide mitigation for many of the impacts which would be expected to occur as a result of the program. The planning aspects of the program would help to identify mitigation for identified impacts. The land use plans and their EIS's on specific lease tracts would develop specific mitigation measures where appropriate. The planning process itself would consider potential impacts, and selection of the areas to be leased would be based on minimizing impacts to the extent feasible. The proposed program would also involve control over the timing as well as the location of the lease tracts. This timing aspect would be useful in helping to control and mitigate socioeconomic impacts.

In addition to the planning and analysis procedures which would help to mitigate impacts, all lessees would be required to comply with applicable federal, state, and local laws. The federal laws which would constrain the development and require mitigation are identified in Table 1-3; they would require protection of such resources as air, water, cultural, and threatened and endangered species. All lessees would also be required to comply with some level of reclamation standards. These standards would be developed during the RMP process and subsequent EIS. They would be tailored specifically for the area to be disturbed. The type of reclamation standards that may be required are illustrated in the draft Uintah Basin Synfuels Development EIS (BLM 1982g).

The potential socioeconomic impacts which could result from implementation of the proposed leasing program would be of major concern. The states of Utah and Wyoming have specific laws covering the mitigation of these impacts. In Utah, the applicable law is Senate Bill 170, which would require each lessee to submit a financial impact statement and plan to alleviate socioeconomic impacts of their planned development. Approval of each plan is required before the state would issue any required construction permits such as a Prevention of Significant Deterioration (PSD) permit.

In Wyoming the applicable act is the Wyoming "Industrial Development Information and Siting Act" (WS35-12-101 through 35-12-101; Laws 1975, Chapter 169; Laws 1977, Chapter 66). This act established the Industrial Siting Council and also requires all developers who meet the criteria of the Act (including a shale and processing facility) to submit a plan or proposal for alleviating social, economic, and environmental impacts upon local government. Approval of the plan is required before the council will grant a permit for constructing the facility.

Provisions requiring submittal of a socioeconomic mitigation study could be attached to any lease. The following provisions are an example of possible socioeconomic mitigation requirements that could be applied in any state.

Concurrently with the filing of the lessee's development plan, the lessee shall prepare and submit to BLM a social, economic, and transportation impact data study, concerning off-site aspects of the proposed development, which will include the following (estimated figures):

(1) The number of employees that the specific lease operation will require during its phases of construction and operation and the specific years during which each number and type of employees will be required;

(2) The transportation mode(s), route(s) and frequency of trips for the extracted resources;

(3) Contemplated construction of transportation facilities;

(4) The effect of any truck movements on the rate of roadway pavement deterioration, the design life of the transportation mode, the level of surface repair, and the overall safety to the motoring public;

(5) The effect of the influx of population resulting from the proposed development on the transportation system at the county and local level.

The study data will be updated:

(1) Annually, during the construction phase and operation phase until a full or stable level of operation is reached;

(2) Thereafter, whenever a major change in the operation is planned (expansion, change of transportation mode, closing, etc.). This update will be provided at the time plans for such a change are made, not at the time of implementation.

ALTERNATIVES

No-Action

Development of a permanent oil shale management program with its attendant regulations would not occur under this alternative. However, impacts may occur through other types of energy and non-energy activities, as well as developing private and state leases and existing and planned 1984 federal prototype oil shale leases. The major assumption used in analyzing this alternative was that federal rights-of-way required to allow development on private and state leases would be granted as needed.

Program Alternatives

Figure 1-2 provides an overview of the steps and time frames involved with the proposed action program and each program alternative.

ACTIVITY PLANNING PROGRAM

The states of Colorado, Utah, and Wyoming have proposed an alternative approach to the oil shale management program through the ROST. The states' approach includes two phases: (1) preparing regulations and general land use plans, and (2) implementing the activity planning program, including tract delineation and lease decision.

Phase One

Regulations. BLM would prepare regulations as a framework to govern the direction of the leasing program and to establish procedures to determine the appropriate levels, conditions and locations of leasing. This general framework would be both independent of and applicable to whatever pace, level, and location of actual leasing that eventually could occur. The regulations would be developed with the expectation that land use plan updating would be infrequent. They would cover general policies; a description of the ROST's

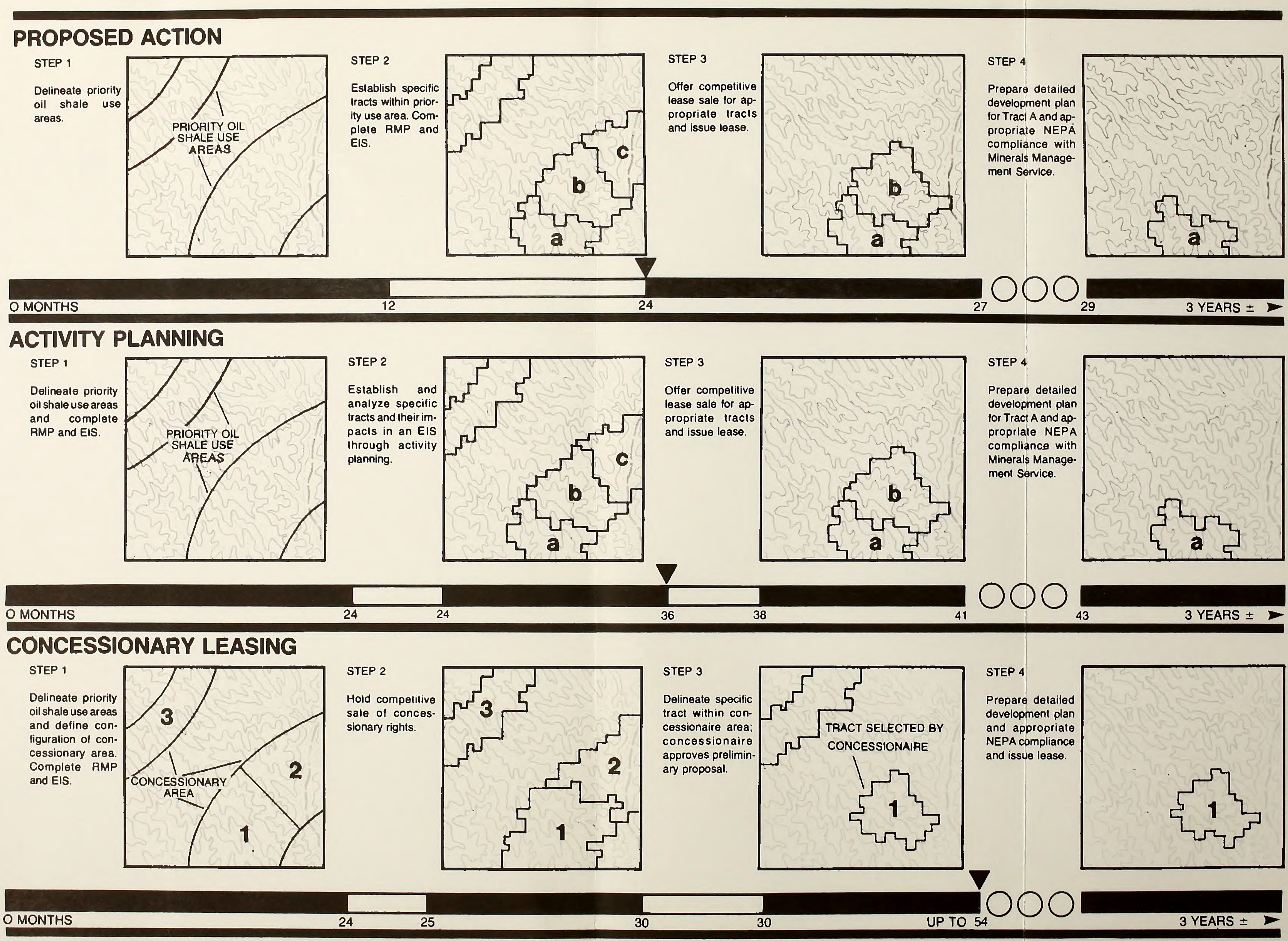
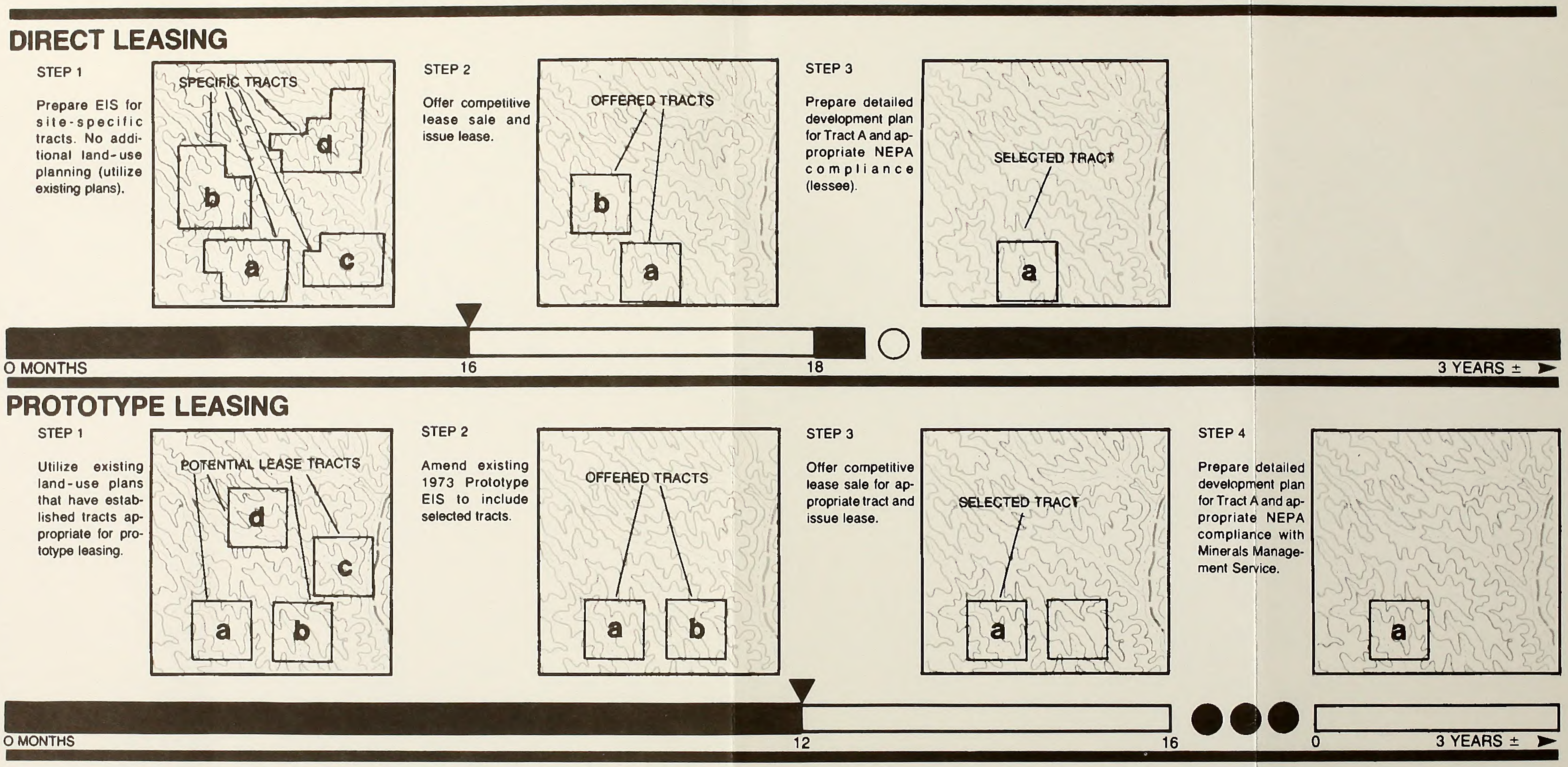

PROPOSED ACTION
STEP 1
Delineate priority oil shale use areas.
PRIORITY OIL SHALE USE AREAS
STEP 2
Establish specific tracts within priority use area. Complete RMP and EIS.
a
b
c
STEP 3
Offer competitive lease sale for appropriate tracts and issue lease.
a
b
STEP 4
Prepare detailed development plan for Tract A and appropriate NEPA compliance with Minerals Management Service.
a
O MONTHS
12
24
27
29
3 YEARS ±
ACTIVITY PLANNING
STEP 1
Delineate priority oil shale use areas and complete RMP and EIS.
PRIORITY OIL SHALE USE AREAS
STEP 2
Establish and analyze specific tracts and their impacts in an EIS through activity planning.
a
b
c
STEP 3
Offer competitive lease sale for appropriate tracts and issue lease.
a
b
STEP 4
Prepare detailed development plan for Tract A and appropriate NEPA compliance with Minerals Management Service.
a
O MONTHS
24
24
36
38
41
43
3 YEARS ±
CONCESSIONARY LEASING
STEP 1
Delineate priority oil shale use areas and define configuration of concessionary area. Complete RMP and EIS.
CONCESSIONARY AREA
1
2
3
STEP 2
Hold competitive sale of concessionary rights.
1
2
3
STEP 3
Delineate specific tract within concessionaire area; concessionaire approves preliminary proposal.
TRACT SELECTED BY CONCESSIONAIRE
1
STEP 4
Prepare detailed development plan and appropriate NEPA compliance and issue lease.
1
O MONTHS
24
25
30
30
UP TO 54
3 YEARS ±

FIGURE 1-2 A COMPARISON OF THE PROPOSED ACTION AND PROGRAM ALTERNATIVES



DIRECT LEASING

STEP 1

Prepare EIS for site-specific tracts. No additional land-use planning (utilize existing plans).

STEP 2

Offer competitive lease sale and issue lease.

STEP 3

Prepare detailed development plan for Tract A and appropriate NEPA compliance (lessee).

PROTOTYPE LEASING

STEP 1

Utilize existing land-use plans that have established tracts appropriate for prototype leasing.

STEP 2

Amend existing 1973 Prototype EIS to include selected tracts.

STEP 3

Offer competitive lease sale for appropriate tract and issue lease.

STEP 4

Prepare detailed development plan for Tract A and appropriate NEPA compliance with Minerals Management Service.

▼ TRACT DECISION

FIGURE 1-2 (CONTINUED)

role in program development and their general operation and composition; prelease procedures and decisionmaking criteria for each leasing cycle; bidding and lease award procedures or options; and general lease requirements, such as diligence, mine plans, royalties, rentals, and lease terms and conditions.

General Land Use Plans. Simultaneously, with developing regulations, BLM would prepare general land use plans, which would be multiple-use (RMP's) and would identify general areas for leasing and development; but, simultaneously, they would consider other potential land uses and resource values. The general land use plans would be prepared with the expectation that they would be reviewed and updated at appropriate intervals of approximately 5 years if additional oil shale leasing is anticipated.

The plans would identify general (non-tract, specific) areas of most probable leasing, based on industry and public input, ROST's advice, and BLM judgment. The plan would also identify expected areas needed to support oil shale operations on public or private land, such as rights-of-way for transportation, utilities, or other purposes; off-site disposal areas; or community or other infrastructure facilities on private lands. The plans would also identify public resources and other potential land uses (not related to oil shale development) within the planning area.

These plans would help analyze economic, environmental, and other resource values and would identify instances of conflicting or competing land uses, including land title conflicts. Based on these plans, BLM could also develop and analyze alternatives for multiple-use management and could identify preferred or other acceptable land-use management approaches; additionally, estimates of the carrying capacity of selected resources would be included. Finally, based on the above steps, the plans would assist in identifying preferred areas or portions of areas for leasing. There would not be an absolute unsuitability process as in the coal leasing system (oil shale resources would not be eliminated from further consideration by the land use plans during program implementation).

Phase Two

Implementation. The general land use plan would be published as a draft and reviewed publicly. When the final plan is published and adopted, the second phase of program implementation would begin.

Each lease sale would be preceded by: (1) the opportunity for tract-specific expressions of interest in leasing or nonleasing; (2) tract delineation; (3) cumulative and tract-specific analysis, with appropriate consideration of carrying capacity; (4) consistency with general land-use plans: (5) production potential; (6) economic or other benefits; (7) environmental and socioeconomic impact analysis; (8) contemporary nonleasing resource management decisions; and (9) impact mitigation opportunities. The ROST would play a major role in scoping, tract delineation and ranking, cumulative and site-specific analysis, formulating leasing, and associated recommendations. After the final recommendations, the Secretary of the Interior would consult with the governors of Colorado, Utah, and Wyoming, as outlined in the consultation provisions agreed to by them prior to making final leasing decisions. After the lease sale, BLM would issue the lease to the high bidder, provided that bidder passes qualification evaluations and has agreed to all lease terms and payments.

CONCESSIONARY LEASING PROGRAM

The concessionary leasing program would be based on BLM selling lease delineation rights for an area larger than the legal oil shale lease size maximum. Within this area, named the "concession," a company would be permitted to delineate its own tract, seek preliminary approval to lease its delineated tract, file a mine plan, and ultimately acquire a lease with the approved mine plan.

This alternative relies, as does the proposed program, on BLM's land-use planning process, continuing industry input, and environmental analysis of the planning decisions. It differs, in that: (1) tract delineation is deferred until after the sale of lease rights; (2) the primary responsibility for tract delineation and the specific location of oil shale development is shifted from government to the lessee; (3) site-specific environmental analyses are delayed until a detailed development plan is submitted by the lessee, and (4) the ROST's attention is focused on regional planning goals rather than on details of achieving such goals.

There are four basic components to the concessionary lease system (listed chronologically): (1) identification of concession(s) through an RMP, (2) competitive sale of the concession(s), (3) tract delineation within concession(s), and (4) detailed mine plan development. These components are described below.

Concession(s)

Identification of the concession would be dependent upon determination of priority use areas for oil shale. Initially, priority use areas would be identified based on public expressions of interest and MMS's oil shale resource information. Within BLM RMP's, conflicts would be identified between oil shale and other resource. The RMP's would address those conflicts based on multiple-use principles and identify those locations where oil shale development would be the "priority use." Concessions would then be delineated within these priority use areas by BLM and MMS.

Competitive Sale of the Concession(s)

The competitive sale of concessions could take place within months of RMP completion. Upon a Secretarial decision, BLM could announce the proposed sale in the Federal Register, specifying bidding systems, royalty payments, and any concessionary stipulations. The sale of the concession would (1) convey the rights to exploration within the concession for a maximum of 2 years (non-exclusive right); (2) propose a lease within the concession; (3) seek BLM review and preliminary approval of a proposed lease tract; (4) submit a detailed development plan for the proposed lease tract; and (5) gain full lease issuance and mine plan approval, if a development plan is acceptable to the MMS and BLM after NEPA evaluation. By the time of the lease sale, the successful bidder should understand that a concession right is not an absolute guarantee that a lease will be issued.

Tract Delineation within Concession(s)

Tract delineation within any concession could be conducted by the company which obtains the concession. That company would have a 2-year opportunity to explore the quantity and quality of oil shale within the concession prior to tract delineation. Exploration would be conducted under an exploration plan submitted by the concessionaire and approved by MMS. At the end of the exploration phase, the concessionaire would present to MMS the tract proposed for leasing, an estimate of the oil shale reserves contained therein, the proposed mining method and sequence, the estimated resource recovery, and the general location of the processing and ancillary facilities. Preliminary approval to lease the tract would be granted, if the proposed lease tract appears to conform with the conditions of the sale and legal constraints, such as size limitations.

Detailed Mine Plan Development

Detailed mine plan development could commence upon preliminary approval of the lease tract. Within 7 years, the concessionaire would be required to submit a detailed development plan to MMS. This plan would act as an application to mine and would detail on-site and off-site impacts, with particular emphasis on mining and reclamation. MMS would evaluate the impacts of the mine plan in accordance with NEPA and would prepare a decision document addressing the issuance of the lease, mitigation, and mine plan approval. If acceptable to the Secretary or the Secretary's designated official, the mine plan would be approved and the lease would be issued simultaneously. The concessionaire, who would then become the lessee, would then be able to pursue oil shale developments.

DIRECT LEASING PROGRAM

Permanent oil shale leasing could be conducted after an EIS is completed that analyzes the cumulative impacts of leasing specific tracts. Under this alternative, no codified regulations would be prepared, as leasing would comply with the broad authority of the MLLA and with the specific requirements of the Council on Environmental Quality's (CEQ) regulations for NEPA implementation (40 CFR 1500-1508). No further land-use or activity planning would be conducted, provided that leasing is not inconsistent with existing land-use plans.

Chronologically, this alternative would start with soliciting industry leasing interests through BLM. Oil shale companies would either submit expressions of interest or lease applications to BLM in response to a Federal Register notice. Provisions to accept leasing input (both pro and con) from other public or government parties could also be announced (via this same Federal Register notice). Upon receiving any leasing interests, BLM and MMS would delineate potential lease tracts, based on publicly supplied information, as well as existing government data. ROST would be given an opportunity to provide BLM with both tract delineation criteria and recommendations on locations of specific tract delineation.

Upon completing the delineation of a set of potential lease tracts, BLM would prepare a lease sale EIS that would address the cumulative impacts of leasing all (or any combination of) the tracts and potential mitigation measures (i.e., lease stipulations). The foundation of that EIS would be a series of site-specific analyses of oil shale development on each individual tract. If the Department chooses to identify a preferred alternative (i.e., which specific combination of tracts it prefers to lease), the ROST would be asked to assist in this effort by recommending a preferred alternative.

Thirty days following publication of the final EIS, the Secretary would be able to announce a lease sale. Any Secretarial decision to lease would be done after a ROST recommendation on tract selection. The Secretary's decision on which leases to offer, together with bidding procedures, royalty payments, and all lease terms and stipulations would be made public at least 30 days prior to the sale.

After the lease sale, BLM would issue the lease(s) to the highest respective bidder(s), provided those bidders meet legal qualifications and agree to all lease terms and payments. Upon lease award, the lessee would be required to apply for and gain approval of an oil shale mining and development plan. Oil shale development could commence upon MMS's approval of such a plan in accordance with 30 CFR 231.

PROTOTYPE LEASING PROGRAM

The Department has the option to expand the prototype program and to not adopt any permanent program regulations. If the Secretary decides to extend and expand the prototype program, he could offer additional prototype leases up to the magnitude described by this EIS under the high federal leasing level.

Implementing this alternative would require extensive further analysis (i.e., a call for further prototype expressions of interest in Colorado, Utah, and Wyoming; tract delineation; a cumulative lease sale EIS for the area of the delineated tracts; and an evaluation of the consistency of the delineated tracts with federal, state, and local land use plans). The adoption and implementation would be done in consultation with the ROST.

Energy Conservation Alternative

An alternative to the proposed oil shale leasing program is energy conservation, the wise and efficient use of available energy sources. The United States currently (1981) consumes the equivalent of 16.06 million barrels of oil per day for energy needs (DOE 1982). The Department of Energy has estimated that current trends in energy conservation could provide the equivalent of 11 million barrels of oil per day by 2000 (DOE 1975).

A federal conservation program might include one or more of the following:

- Mandated improvement in vehicular gas mileage performance beyond 1985.
- Increased support for mass transit and ride-sharing programs in urban areas.
- Residential and commercial energy audits and support for retrofit programs.
- Mandated appliance efficiency.
- Mandated retirement of older, inefficient vehicles from use.
- Tax credits and loans to increase industrial energy conservation, such as recovery of waste and cogeneration.
- Set utility rates to encourage conservation.

Implementation of this alternative would require actions not within the jurisdiction of the Department of the Interior.

Alternative Energy Fuels

An alternative to the proposed oil shale leasing program is the accelerated development of oil and coal, and synthetic fuel from coal. The degree to which some or all of these domestic energy sources could substitute for federal oil shale development depends largely on current and subsequent administrative policy. A detailed description of current policy and federal incentives for research and development of domestic energy sources may be found in several publications, such as A National Plan for Energy Research, Development and Demonstration (U.S. Energy Research and Development Administration 1977), and Energy Alternative - A Comparative Analysis (University of Oklahoma 1975).

Although natural gas, geothermal energy, hydroelectric power, nuclear power, and solar energy are normally considered as alternative fuels, they are not comparable to the proposed action being considered in this EIS. These sources would not be a replacement for the oil that could be produced as a result of implementing the proposed action, since shale oil is basically used as an oil product (e.g., refined into gasoline) and not to produce electricity as the listed sources do. Although a brief description of these alternative sources is presented, they are not considered as viable alternatives and are not considered further in this EIS.

OIL

Oil is used to meet 40 percent of all the primary energy needs of this country each year (DOE 1981). Total oil consumption has been declining in the United States for the past 4 years; in 1982, it is predicted to be 16.2 million barrels per day (DOE 1981).

Production of domestic crude oil has declined sharply from an historic peak in 1970, to a projected 8.41 million barrels per day in 1982 (DOE 1981). With anticipated further expansion of Alaskan North Slope production and domestic exploration, the Department of Energy projects a short-term increase in domestic oil production; however, output from the North Slope is expected to peak around 1990. Total domestic production (onshore and offshore) in 2000 is projected to be approximately 10 to 11 million barrels per day (DOE 1979).

Oil imports declined to 6.1 million barrels per day in 1981, but are projected to rise in 1982 in spite of a decline in consumption (DOE 1981).

COAL

Coal is the most abundant fossil fuel in the country (DOE 1981). Consumption of domestic coal has enlarged due to increased coal use by electric utilities; it is projected to be 768 million tons in 1982 (DOE 1981).

Production of domestic coal rose approximately 5 percent annually between 1975 and 1980. Coal production dropped slightly in 1981 due to the United Mine Workers of America strike; it is expected to be up in 1982 to a record high of 887 million tons; more than 100 million tons of coal are expected to be exported in 1982.

Approximately half of the Nation's coal reserves are located west of the Mississippi River; however, until recently, western reserves played only a limited role as a source of the country's coal production. In the past, heavy demand from eastern and midwestern population and industrial centers has been satisfied with coal from mines in Appalachia and the Midwest (BLM 1980a).

Approximately 60 percent of the Nation's western coal reserves is owned by the federal government and an additional 20 percent is dependent for its production on the availability of complementary federal coal.

SYNTHETIC FUEL FROM COAL

The United States has valuable hydrocarbon resources in the form of coal. Existing processes can extract those resources and transform them into synthetic substitutes for conventional oil and gas. It has been projected that improved coal conversion technology may provide approximately 0.4 quadrillion Btu's per year by 1990, and 2.0 quadrillion Btu's per year by 1995 (DOE 1979).

NATURAL GAS

Natural gas provides more than half of all the energy used within U.S. households and is also a leading commercial fuel. Total natural gas consumption is expected to rise in 1982, to 20.3 trillion cubic feet (DOE 1981). However, natural gas consumption by electric utilities is projected to decline by 5.6 percent in 1982, as natural gas is, to some extent, displaced by rapidly growing coal and nuclear-powered electricity generation (DOE 1981).

The pattern of domestic production of natural gas has closely followed that of crude oil. Natural gas output peaked in 1973 and has since declined. The Natural Gas Policy Act of 1978 aimed to stimulate greater production of domestic gas supplies by raising the regulated price and providing for deregulation by 1985. In the short term, the Act's most significant consequence has been to abolish the price differential between interstate and intrastate gas, which has resulted in increased gas supplies. Domestic production is projected to be 19.6 trillion cubic feet in 1982 (DOE 1981).

Historically, imports of natural gas have provided a relatively small portion of the Nation's energy needs. Net imports are projected to be about 4 percent of total consumption in 1982. A slight increase is expected from supplies from Alberta, Canada, delivered by the recently completed Alaska Natural Gas Transportation System.

GEOTHERMAL ENERGY

Geothermal energy is heat that is stored in the earth. Technology is now evolving to recover the heat for both electricity and thermal energy from some sites, given favorable characteristics. There are three types of geothermal energy: hydrothermal, geopressured, and hot dry rock. Hydrothermal resources are systems of hot water or steam which are trapped in fractured rocks or porous sediments overlain by impermeable surface layers. Many promising hydrothermal reservoirs have been identified in the West. Geopressured resources are hot water aquifers containing dissolved methane trapped under high pressure in sedimentary formations and are found along the Gulf Coast. Hot, dry, rock resources are geologic formations at accessible depths that contain considerable heat but little or no water (DOE 1979).

HYDROELECTRIC POWER

In 1977, hydroelectric plants accounted for 68,300 megawatts or 12 percent of the total installed electrical generating capacity of the United States, approximately 25 percent less than in 1974, due primarily to drought conditions in many western states. In the 1930's and 1940's, hydroelectric power provided as much as 30 percent of the total domestic electricity needs

(DOE 1977). Although hydroelectric power is relatively safe, nonpolluting, low in cost, and does not consume fuel, its expansion in recent years has been limited by the lack of sufficient new sites, high costs, and environmental opposition. The possibilities for expanding capacity at existing dams and for developing hydroelectric facilities on smaller rivers and streams are being investigated (DOE 1978).

NUCLEAR POWER

Nuclear-powered electricity plants first began operation in the United States in the early 1970's. By 1978, 71 nuclear power plants were operating in 26 states. Recently, construction of authorized plants have been delayed or cancelled for a variety of reasons. This is due, in part, to public concerns over nuclear waste management, the safety of reactor operations, health and environmental risks, and the national economy.

SOLAR ENERGY

The basic solar energy categories are solar heating and cooling of buildings, agricultural and industrial process heat, wind energy conversion, photovoltaic conversion, solar thermal conversion, and biomass conversion. Solar heating and cooling, agricultural and industrial process heat, wind energy, and biomass appear to have potential for significant uses between now and 1990. The most promising of these is biomass, which is expected to displace from 3.1 to 5.4 quads (quadrillion Btu's) per year of conventional energy by 2000, when the total national annual energy consumption is expected to be approximately 100 to 115 quads. Industrial and agricultural use of solar energy may displace less than half a quad, but photovoltaics could displace up to 1 quad and wind energy may displace from 0.6 to 1.7 quads of conventional energy in 2000. These estimates would be higher if maximum technically feasible expansion of United States solar energy use were assumed (DOE 1979).

CHAPTER 2
DESCRIPTION OF AFFECTED ENVIRONMENT

INTRODUCTION

Chapter 2 is divided into two major sections: a summary of the oil shale reserves and a description of the affected environment.

The scope of the EIS has been narrowed to include only the more significant oil shale reserves in the country, located in the three-state region of Colorado, Utah, and Wyoming, which is defined for this EIS as the oil shale region. Environmental resource categories are briefly discussed; of these, air quality and socioeconomics are discussed on state basis; all other resources are described for the oil shale region as a whole.

Even though this EIS focuses on the three-state oil shale region, the proposed program would apply to all areas of oil shale resources administered by the Department of the Interior. If other deposits of oil shale are determined to be economically minable, and if they are leased, the provisions of the proposed program would apply and the same type of impacts could be expected to occur.

LOCATION AND DESCRIPTION OF OIL SHALE RESERVES

The western oil shale reserves are found in eight states (see Table 2-1 and Figure 2-1). The Minerals Management Service (MMS) recently classified 80,919 acres of the Nevada oil shale deposits on BLM lands as prospectively valuable (Federal Register 1982). Montana and Kansas oil shale deposits are also located on federal lands. However, these reserves are low grade, yielding less than 25 gal/ton of oil shale. An undetermined amount of Alaskan oil shale deposits are located on federal lands. Rich deposits averaging 160 gal/ton of oil shale are located in seams only 1 to 2 feet thick and are not considered an economic reserve at the present time. Less than 1 percent of the oil shale reserves in California are located on federal lands.

Table 2-1 shows that about 60 percent of the recoverable oil shale reserves in the United States occur in the Green River Formation of Colorado, Utah, and Wyoming. This 17,000-square-mile area covers the Piceance Creek Basin in Colorado, Uinta Basin in Utah, and the Washakie and Green River basins in Wyoming. The estimated recoverable reserves are 600 billion barrels of shale oil; these high grade shale deposits average 25 gal/ton in beds at least 10 feet thick. Eighty percent of this area is administered by the federal government. For these reasons, this EIS focuses on this region (Map 2-1); official acreage is approximately 28 million acres.

TABLE 2-1

OIL SHALE RESERVES IN THE UNITED STATES [1]

	Total Oil Shale Reserve Area (mi^2)	Recoverable Shale Oil (billion bbl)	Fischer Assay[2] (gal/ton) Range Minimum	Maximum	Thickness of Deposits (ft)	Other Minerals in Deposits	Type of Shale/ Age/Name	Percent owned by Federal Government[2]
Eastern States								
Alabama	300	4	2	3	5 - 40		Black Devonian/ Mississippian Age	---
Illinois	Minor	---	---	20	150 - 450		Black Devonian/ Mississippian Age	---
Indiana	600	40	20	30	100 - 300		Black Devonian/ Mississippian Age	---
Kentucky	2,650	190	10	23	30 - 100		Black Devonian/ Mississippian Age	---
Michigan	160	5	0 - 10	17	100 - 650		Black Devonian/ Mississippian Age	---
Ohio	980	140	9	12	60 - 300		Black Devonian/ Mississippian Age	---
Pennsylvania and New York	---	---	1	---	---		Black Devonian/ Mississippian Age	---
Tennesse	1,540	44	12	42	5 - 50		Black Devonia/ Mississippian Age	---
Western States								
Alaska	---	450	15	160	1-2, 20		Tasmarite Black Shale	---
California[3]	---	2	15	42	---		Monterey Shale/ Miocene Series	Less than 1
Colorado	5,800	1,200	25	30 or more	10 - 200	Nahcolite Dawsonite	Tertiary/Eocene Series	79
Kansas	---	3	6 - 12	22.8	---		Black Devonian	---
Montana	2,700	180	10	19.6	160	Vanadium oxide, nickel, zinc, selenium, molybdenum	Black Devonian/ Mississippian	60
Nevada	126	---	14	28	0.4		Carbonaceous/ Devonian Age	---
Utah	9,750	320	25	30 or more	45 - 90		Tertiary/Eocene Series	77
Wyoming	7,155	430	25	30 or more	10 - 42	Trona	Tertiary/Eocene	70

Sources: Colorado Energy Research Institute and Colorado School of Mines Research Institute 1981, Desborough 1981, Donnel 1967, Hallmark 1980, Runnels 1952, Russell 1980, Survey of Eastern Oil Shale Issues and Activities 1981.

[1] Dotted lines indicate information is not available at present.

[2] Most of the oil shale land in the eastern states is owned by the state govenrment or the private sector.

[3] Little California oil shale information is available

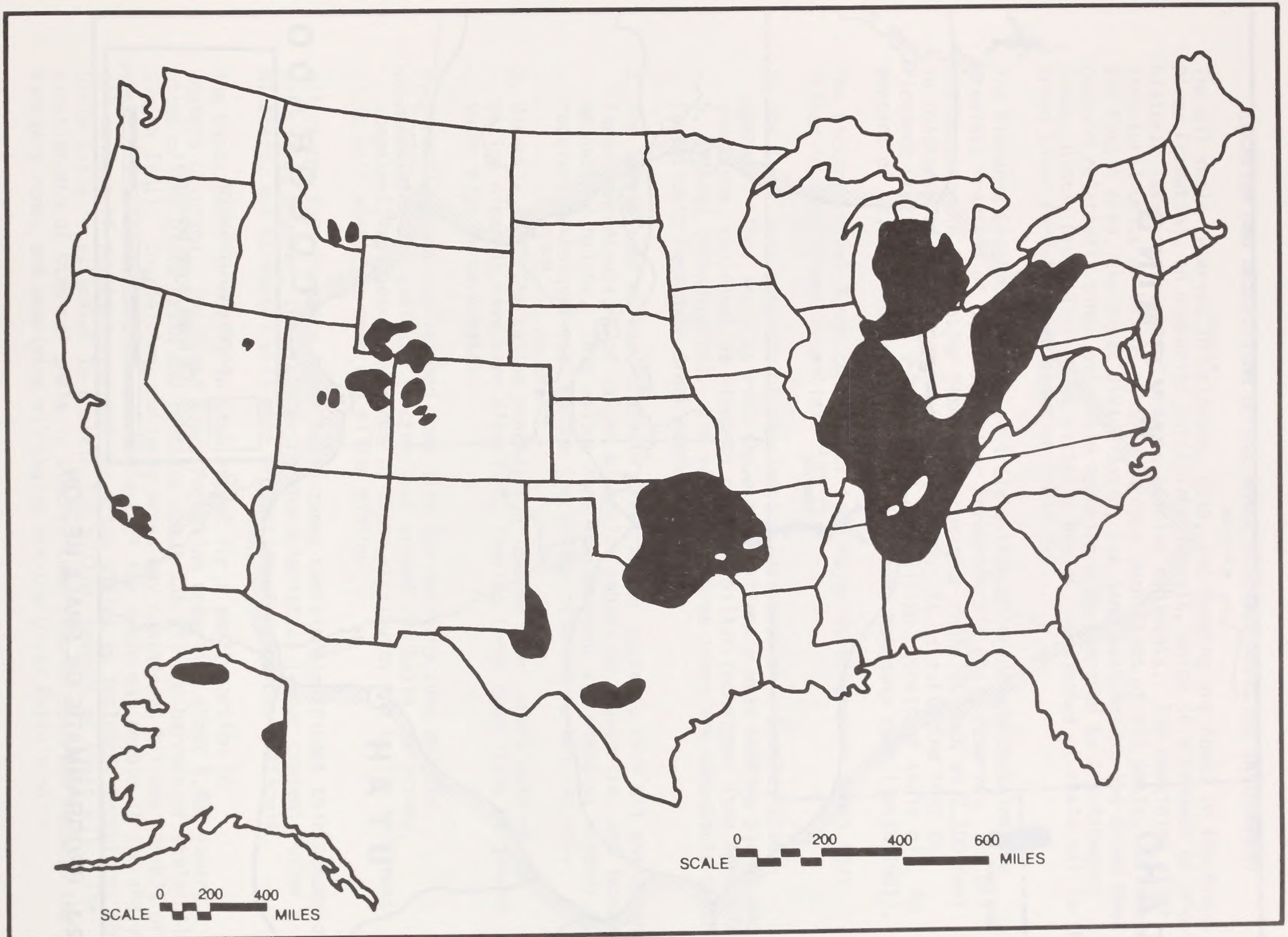
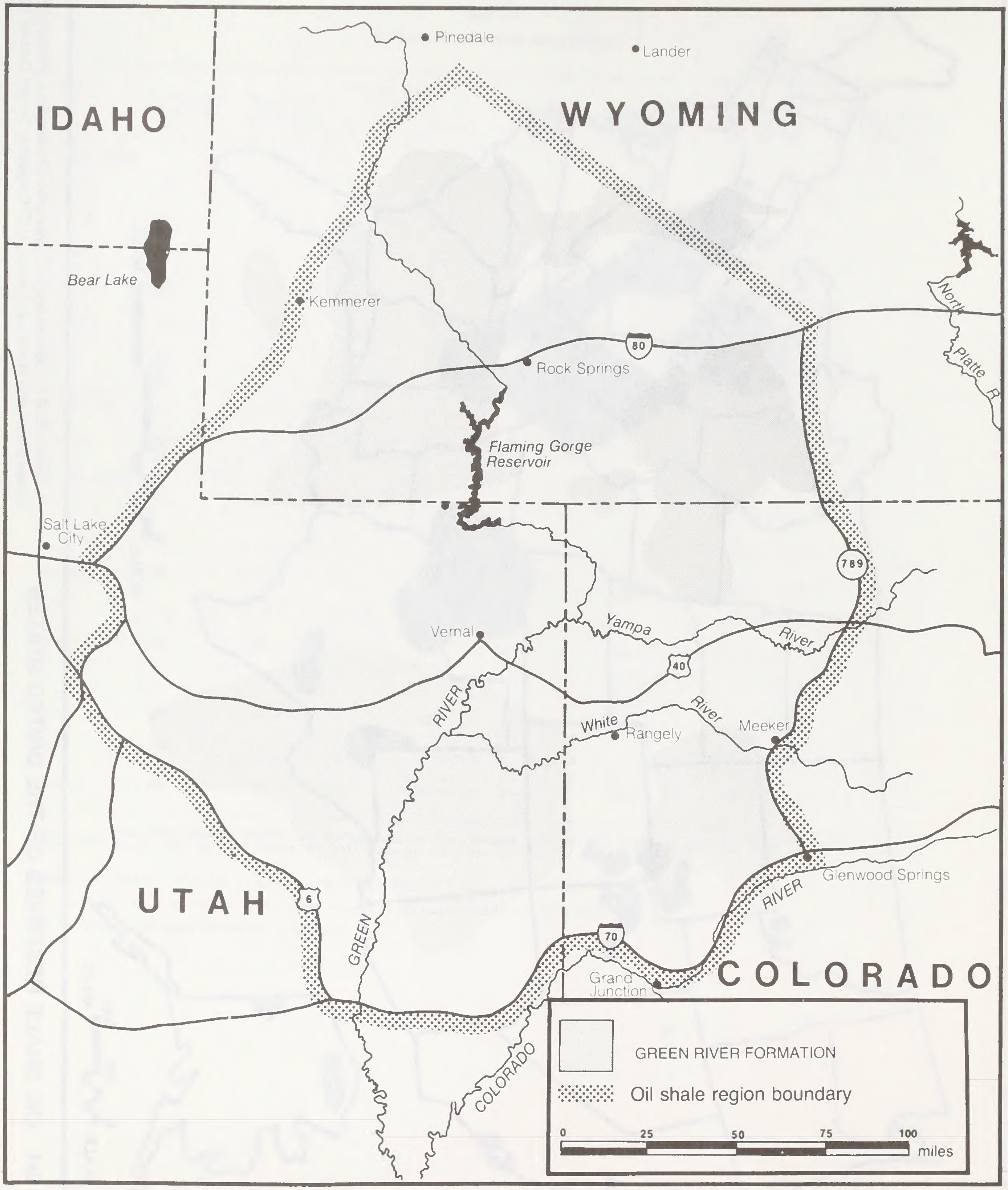


FIGURE 2-1 OIL SHALE RESERVES OF THE UNITED STATES

SOURCE: D.C. Duncan and V.E. Swanson, *Organic-Rich Shales of the United States and World Land Areas*, U.S. Geological Survey Circular 523, 1965.



MAP 2-1 PROGRAMMATIC OIL SHALE REGION

LOCATION AND DESCRIPTION OF OIL SHALE RESERVES-AFFECTED ENVIRONMENT

The oil shale reserves in Colorado, Utah, and Wyoming are found in the Green River Formation, an evaporite basin/lake deposit, which is a remnant of prehistoric lakes that trapped organic-bearing sediments. The remaining eight structural units or basins contain various quantities of oil shale. Of these, the Fossil Area, the Great Divide Basin, the Sand Wash Basin, and Grand Mesa contain relatively minor oil shale deposits when compared to the Piceance Creek, Uinta, Green River, and Washakie basins. Estimates of shale oil in the Green River Formation are shown in Table 2-2.

The Piceance Creek Basin lies entirely within Colorado and contains the greatest fraction of the Green River Formation oil shale reserve. The oil shales occur in four major zones that together range as much as 2,100 feet in thickness of nearly continuous oil shale. It is estimated that the Piceance Creek Basin has a total of 1,035 billion barrels of shale oil, 40 percent of which is contained in the well-known Mahogany zone (Smith 1981).

The Piceance Creek Basin consists of four major stratigraphic zones that differ in development potential.

1. The lower zone consists of overlapping Garden Gulch - Douglas Creek members. They are clay rich shale with extremely weak bedding planes and, therefore, could not be mined by room and pillar techniques (see Appendix 5, Typical Technologies). The remaining three zones are components of the Formation's Parachute Creek member.

2. The lowest zone of the Parachute Creek member contains rich oil shales and large concentrations of saline minerals: nahcolite, dawsonite, and lesser amounts of halite. This saline zone is competent and minable; however, recovery techniques must manage the saline minerals as well as oil.

3. Directly above the saline zone lies a leached zone, where much of the saline minerals have been dissolved, leaving large quantities of ground water high in carbonates.

4. Directly above the leached zone lies the Mahogany zone and its associated oil shales. It crops out around the basin, is strong, competent, and nearly dry; due to these attributes and to its thickness; it is well suited to room and pillar mining.

All of the four Piceance Creek Basin zones contain significant thicknesses of oil shale; however, their differing characteristics (water content, other minerals, and strength) will make production of resources difficult.

The Uinta Basin is mostly in Utah except for a small portion in western Colorado. The Green River Formation underlies about 5,400 square miles of the Uinta Basin and contains about 135 billion barrels of shale oil (Smith 1981). In addition, outlying areas may contain 30 billion barrels of shale oil. The total shale oil content of the basin may double if the shale oil content of discontinuous and low grade shales is included; therefore, the Uinta Basin is estimated to contain 330 billion barrels of shale oil. The stratigraphy of Utah oil shale is simpler than that of Colorado because the Mahogany zone, and overlying oil shales are the Uinta Basin's major

TABLE 2-2

OIL SHALE POTENTIAL WITHIN GREEN RIVER FORMATION (billion bbl)

State/ Basin	High Grade, Continuous Shale	Low Grade, Discontinuous Shale	Total
Colorado/ Piceance	1,035	----	1,035
Utah/ Uinta	135	135	270
Wyoming/			
Green River	250	100	350
Washakie		50	50
Total	1,420	285	1,705

Source: Smith 1981

Note: bbl = barrels; ----- = unknown quantities.

components. However, unlike Colorado, the Mahogany zone in Utah is discontinuous across the basin; thus, lease selection and mine siting will be very important to maximize production.

The Green River and Washakie Basins lie almost entirely within Wyoming but extend into northwestern Colorado. The Green River Basin is estimated to have a potential shale oil content of 250 billion barrels, at a yield of at least 15 gal/ton (Smith 1981). In addition to this, lower grade shales may increase the shale oil content of the basin 40 percent to 350 billion barrels of shale oil. Knowledge of the Washakie Basin is less accurate than that of the Green River Basin; however, Washakie Basin shale oil content is estimated at 50 billion barrels. The Green River Formation in these two basins has 400 billion barrels of shale oil in its sediments.

The lowest member of the oil shale-bearing Green River Formation in Wyoming is a clay rich shale known as the Tipton member. Above this is the Wilkins Peak member, discontinuous and containing remarkably pure deposits of trona (industrial chemical soda ash). The Laney member overlies this and is a high-yielding oil shale bed. Although the stratigraphy of the Green River and Washakie basins is similar, their depositional centers differ. For instance, at one test hole in the Green River Basin, the Tipton member is poorly represented but becomes much richer and thicker to the south. Similarly, the Wilkins Peak member is discontinuous, and the Laney member is richer and more continuous in other parts of the basin.

Oil shale reserves are also found throughout vast areas (approximately 400,000 square miles) in the eastern United States (see Figure 2-1). Oil shales containing an estimated 400 billion barrels of shale oil underlie 6,230 square miles in Ohio, Kentucky, Tennessee, Indiana, and the Appalachian basins. These marine shales average 10 or less gal/ton (Survey of Eastern Oil Shale Issues and Activities 1980).

Although the reserves in the eastern states cover large areas, they lie beneath a considerable overburden. Due to this, their low grade, and general lack of federal ownership, they will not be considered further in this EIS.

AFFECTED ENVIRONMENT

The following discussions of the major resource categories depict the current (1982) situation and are presented in order of public interest, as raised in the scoping process, and in order of a logical progression of information.

Air Quality

The oil shale region has a semi-arid, mid-continent climate, with local variations due to terrain and elevation. Most air masses are of Pacific origin but arrive only after modification from west-lying mountain ranges. Large-scale wind patterns are modified as they cross the rugged, complex terrain. Prevailing winds are from the west-southwest. Dispersal of pollutants, both natural and industrial, is largely a function of air movements through the terrain types.

AFFECTED ENVIRONMENT-AIR QUALITY

COLORADO

The Colorado portion of the air quality study area is characterized by two major dispersion regions: the mountains in the east and the tablelands and plateau regions to the west. In this area, box canyons and mountain valleys are likely to have the poorest dispersion.

There are two main air basins in this area, the Craig air basin containing the Yampa and White rivers as main drainage valleys and the Colorado-Gunnison air basin containing the Colorado and Gunnison rivers as main drainage valleys.

The headwaters of each river are in rugged mountain areas that control diurnal mountain valley wind flows affecting the transport ad dispersion of pollutants.

The area is designated as Class II by the Clean Air Act, as amended, August 1977, except for the special areas designated as Class I areas including the Maroon Bells/Snowmass Wilderness, Flat Tops, and Mount Zirkel Wilderness areas. The Dinosaur and Colorado National Monuments are also proposed Class I areas, but currently have Class II PSD status.

Air quality in the area is generally good. There are no non-attainment areas for National Ambient Air Quality Standards (NAAQS)(Appendix 2, Table A-2-1), except for an area around Grand Junction, Colorado that is non-attainment for Total Suspended Particulates (TSP). There are no areas of total consumption of Prevention of Significant Deterioration (PSD) Class I or Class II increments.

UTAH

The Utah portion of the air quality study area is dominated by the Uinta Basin, which is bound on the north and west by the Uinta and Wasatch mountain ranges. Prevailing winds are generally east to southeasterly or west to southwesterly. A high frequency of inversions have been attributed to nighttime cooling and the sinking of air from higher elevations to the low-lying areas in the basin.

The average thickness of the inversions in the basin is greatest in fall (409 m) and summer (362 m), and least in spring (253 m) and winter (243 m). Wintertime inversions are more stable because of less surface heating, which affects dispersion in the basin by influencing the atmospheric stability.

The area is designated as Class II by the Clean Air Act, as amended, August 1977, except for the areas designated as Class I areas. These include Arches and Canyonlands National Parks which are located in the southern end of the air quality study area. Dinosaur National Monument and the High Uintas Primitive area are also proposed Class I areas, but currently have Class II PSD status.

Air quality in the area is generally good. There are no non-attainment areas for NAAQS or areas of total consumption of PSD Class I or II increments.

WYOMING

The Wyoming portion of the air quality study area, dominated by the Sublette Air Basin, is located in southwestern Wyoming bound by the Wyoming/Utah border to the south, the Bear River Divide and Wyoming Range to the west, and the Wind River Range and Great Divide Basin to the north and east. Prevailing winds are from the west and southwest throughout the year. Regional dispersion is the result of strong surface heating and moderate to strong winds. Strong winds and sparse vegetative cover contribute to occasional local dust storms.

The area is designated as Class II by the Clean Air Act, as amended, August 1977, except for the special areas designated as Class I areas. These include Bridger and Fitzpatrick Wilderness areas. The Popo Agie and Scab Creek Primitive Areas and Fossil Butte National Monument are also proposed Class I areas but currently have Class II PSD status. Air quality in the area is generally good. There are no non-attainment areas for NAAQS except for the Trona Industrial Area (Sweetwater County) for TSP. There are no areas of total consumption of PSD Class I or II increments.

Socioeconomics

The socioeconomics for affected counties of the oil shale region are shown on Figure 2-2.

COLORADO

Population figures for the affected Colorado counties are shown in Table 2-3. Mesa County is the population center for the affected area, with 74 percent of the total population. Within Mesa County, Grand Junction is the largest community, with approximately 35 percent of the county's population. Between 1970 and 1980, Garfield and Mesa counties experienced population growth above the state average, while Rio Blanco's annual growth rate was slightly lower than the state's annual growth. Most of the population growth in this area is attributed to immigration as a result of energy industry expansion.

Employment figures in the affected counties are shown in Table 2-4. The region's annual employment growth rate is almost four times the state average for the same time period. Rio Blanco County showed the largest increase in employment within the affected area.

UTAH

Population and employment figures for the affected counties in Utah are shown in Table 2-5. The regional annual increase in employment was 5.4 percent while the state average was 4.1 percent. Grand County was the only county in the region with a growth rate less than the state average, while Uintah and Duchesne counties increased the fastest. Most of the increase in employment is attributed to energy industry expansion, principally the oil and gas industry.

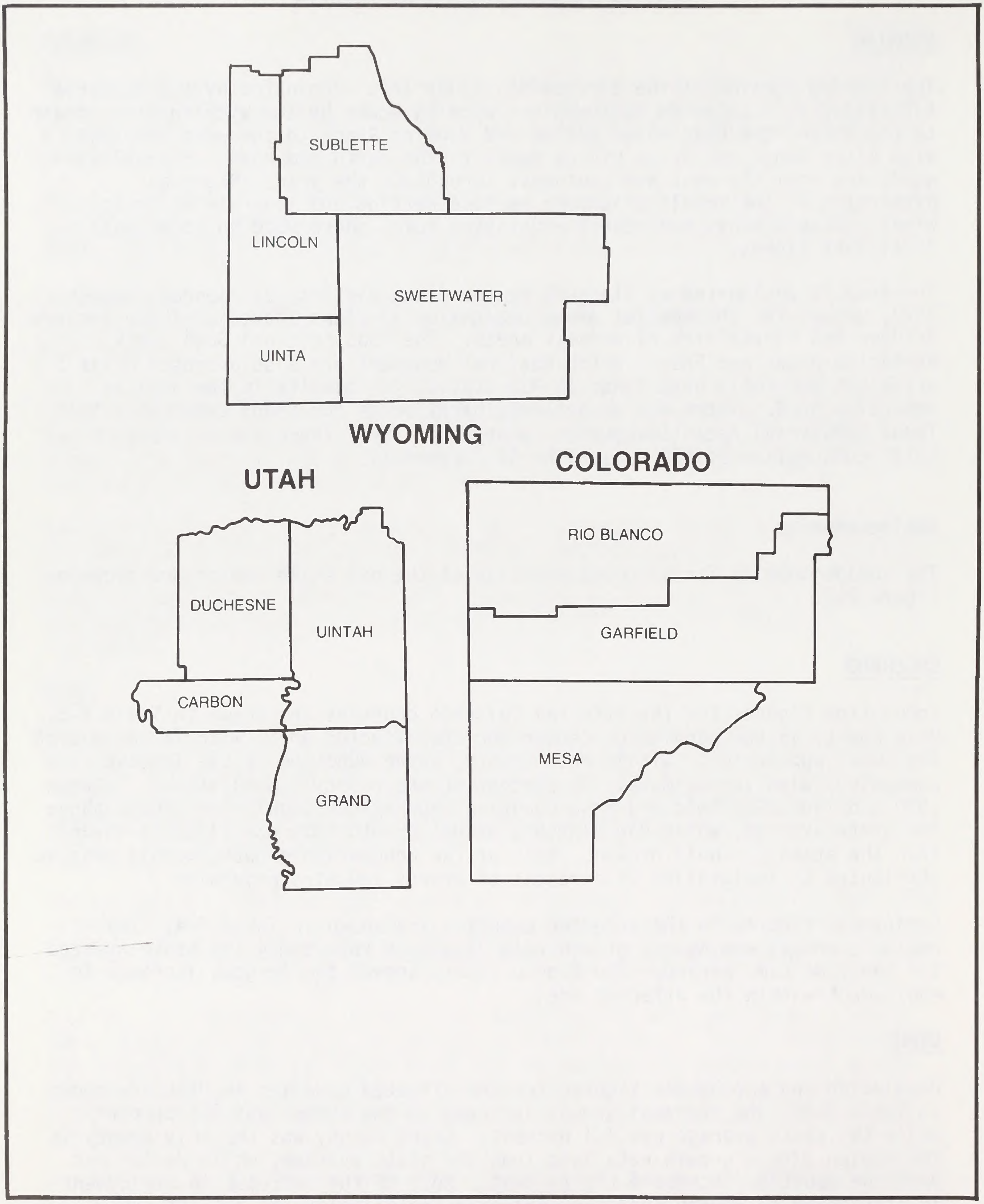


FIGURE 2-2 AFFECTED SOCIOECONOMIC AREA

TABLE 2-3

POPULATION FIGURES FOR AFFECTED COLORADO COUNTIES

County	1970	1980	Percent Annual Increase
Garfield	14,821	22,514	4.3
Mesa	54,374	81,530	4.1
Rio Blanco	4,842	6,255	2.6
Total: Affected Counties	74,037	110,299	4.1
Total: Colorado	2,209,596	2,889,964	2.7

Source: Colorado population reports based on 1970 and 1980 U.S. Census data (Colorado Department of Local Affairs 1971 and 1981).

TABLE 2-4

EMPLOYMENT FIGURES FOR AFFECTED COLORADO COUNTIES

County	1975	1981	Annual % Increase
Garfield	9,268	11,973	5.2
Mesa	27,585	38,020	6.6
Rio Blanco	1,973	3,715	13.5
Total: Affected Counties	38,826	53,708	6.7
Total: Colorado	1,162,038	1,399,968	3.8

Source: Colorado Division of Employment (1975-1980).

TABLE 2-5

POPULATION AND EMPLOYMENT FIGURES FOR AFFECTED UTAH COUNTIES

	Population			Employment		
County	1975[a]	1981[b]	Annual % Increase	1970[a]	1980[b]	Annual % Increase
Carbon	15,647	22,179	7.2	5,249	8,571	5.0
Duchesne	7,299	12,565	11.5	2,627	4,893	6.4
Grand	6,688	8,241	4.3	2,548	3,470	3.1
Uintah	12,684	20,522	10.1	4,463	8,197	6.3
Total: Affected Counties	42,318	63,507	8.4	14,887	25,131	5.4
Total: Utah	1,059,273	1,461,037	6.6	390,700	585,331	4.1

[a] Source: U.S. Bureau of Census 1976.

[b] Source: State Census Data Center 1981.

WYOMING

Population and employment figures for the affected Wyoming counties are shown in Table 2-6 (note that Sweetwater and Uinta were the fastest growing). The Wyoming region population grew at an annual rate of 6.5 percent, which compares to the state's overall rate of growth of 3.5 percent. Most of the regional increase is attributed to energy development, specifically oil, gas and coal production.

The annual employment growth for the region, primarily due to energy development, was substantialy above the state average. For Sweetwater County, however, trona mining was the most significant contributor to growth, although energy development was the second most important contributor.

Quality of Life

Potential commercial-level oil shale development has already had significant effects in Colorado and Utah, but has had less effect on Wyoming communities. The uneven history of interest in the oil shale resource has resulted in pervasive uncertainty among residents on the likelihood of future growth. Local officials do not have solid information on which planning and budgeting (both expected revenues and expenditures) can be based. People have been attracted to the area, figuring on high levels of job opportunities. In summary, the atmosphere resulting from publicly announced plans and changed plans is one of uncertainty and skepticism toward development on the part of local residents.

An additional factor also merits attention. Throughout the Colorado, Wyoming, and Utah region, officials representing communities projected to host growth created by major industrial developments are increasingly aware of both legislative and administrative mechanisms available to respond to expected growth. Negotiations on timely and substantial contributions from the private sector to counties and municipalities are not uncommon. In fact, it is presently widely accepted that such settlements will occur. An institutional example of this trend is the Overthrust Industrial Association in the Evanston, Wyoming area. A similar, voluntary organization in Colorado, the Cummulative Impact Task Force, exists as a means of collaboration between state, federal, local, and private sector entities in forecasting and responding to projected effects.

This means that some of the potential distruptions associated with expected growth likely will not occur. In particular, funding for improvements in services and facilities very likely will be available. Company sponsored housing for temporary and permanent employees likely will be constructed. Similar measures are now prevalent throughout the region and address several (education, law enforcement, parks and recreation, and medical care) functions that have historically been problems for host communities. Other changes are not subject to mitigation through funding provisions. Examples are way of life, interpersonal relations, community diversification, and sense of security changes.

TABLE 2-6

POPULATION AND EMPLOYMENT FIGURES FOR AFFECTED WYOMING COUNTIES

	Population			Employment		
County	1975[a]	1981[b]	Annual % Increase	1970[a]	1980[b]	Annual % Increase
Lincoln	8,640	12,177	7.1	4,198	6,011	3.7
Sublette	3,755	4,548	3.9	1,914	2,342	2.0
Sweetwater	18,391	41,723	17.8	8,238	22,079	10.4
Uinta	7,100	13,021	12.9	3,140	6,443	7.4
Total: Affected Counties	37,886	71,469	13.5	17,490	36,875	7.7
Total: Wyoming	332,416	469,557	7.1	148,815	243,824	5.1

[a] Source: U.S. Bureau of Census 1976.

[b] Source: Wyoming Department of Administration and Fiscal Control 1982.

Regardless, social and economic mitigation measures are not treated here as committed measures. State and local officials possessing appropriate authorities remain responsible for overseeing growth mamagement at the local level.

Water Resources

GROUND WATER

Within the oil shale region there are four basins in which development of oil shale could take place: the Piceance Creek, Uinta, Washakie, and Green River. Each basin has unique ground water characteristics such as amount, quality, and recharge points. However, the basins may be grouped into two categories: those with an abundance of ground water (Piceance Creek and Green River) and those with small amounts of ground water (Uinta and Washakie).

All of the basins have one characteristic in common -- they store water in stream alluvium, which can be developed as a reliable source of relatively high quality water. Many consider this ground water; however, in this EIS, it will be considered as surface water and is discussed in the surface water portion of this EIS.

For purposes of this EIS, ground water will be defined as "water which occurs in bedrock." It not only varies from basin to basin but also varies within each structural basin. Recharge occurs in all basins where the aquifers are exposed at higher elevations near the basin margins. As precipitation enters these higher rock units, it either is discharged to surface water sources through springs and streams, or it seeks deeper avenues of transport and is carried to the structural center of the basin. Here it may be discharged to the alluvium of major streams or temporarily stored in deep rock aquifers.

The Piceance Creek and Green River basins contain large amounts of ground water; however, it is poor in quality especially in the Piceance Creek Basin. The Green River Basin has rather uniform occurrences of ground water, whereas, in the Piceance Creek Basin, the Colorado River and its tributaries are deeply entrenched and partially drain the southern part of the Basin. This draining effect is absent over the remainder of the two basins; thus, a large amount of ground water exists in the oil shale horizons and their associated aquifers. Additionally, large volumes of water may be encountered below the oil shale deposits.

The Uinta and Washakie basins contain lesser amounts of ground water than the Piceance Creek and Green River basins. The Washakie Basin has very small amounts of ground water. The Uinta Basin contains some zones that have relatively larger amounts of ground water; however, they are highly variable in quality and generally discontinuous in nature.

In general, the ground water throughout the oil shale region is unpredictable in quantity, has not been extensively studied (with the possible exception of the Piceance Creek Basin), and the concept of potential interbasin hydraulic connections is, at best, poorly understood. Similarly, the quality of the ground water is variable and it ranges from fresh water to brackish, due to the evaporite deposits which contribute large quantities of dissolved minerals to the ground water.

SURFACE WATER

The entire oil shale region lies within the upper portion of the Colorado River Basin and is characterized by highly dissected, arid basins that have a high density of intermittent streams which collect and rapidly deliver water to the few perennial streams in the area. Streamflow throughout the region is characterized by high flows and low dissolved solids during snow melt (May, June, and July), and low flows and high dissolved solids during September through February, when ground water becomes the primary contributor to streamflow.

The major streams expected to receive cumulative impacts in the area are the Green, Yampa, White, and Duchesne rivers (see Figure A-2-1 in Appendix 2), which collectively drain an area of 44,850 square miles above Green River, Utah. Table 2-7 shows selected characteristics of these streams.

The Colorado portion of the study area contains the Piceance Creek Basin, drained primarily by Piceance Creek which flows year-round and is a tributary to the White River. A small portion of the Piceance Creek Basin drains to the Colorado River; however, the contribution of this portion of the Basin to the Colorado River is insignificant.

The Utah portion of the study area contains the Uinta Basin; only one major stream originates there - the Duchesne River, which drains about half of the Basin and is currently undergoing intensive development for irrigation and out-of-basin transport. The White River also flows through this Basin and is also planned to undergo development. Both of these streams are tributaries to the Green River which divides the Uinta Basin, and is a reliable water source due to upstream storage.

The Wyoming portion of the oil shale region contains both the Washakie and Green River basins. The Washakie Basin is drained by many intermittent streams that are tributaries to other large streams that may flow longer with more water; nevertheless, they are also intermittent in nature. Because this geological basin lies in the headwaters of several drainage basins, there are no streams which have significant flows. However, the Yampa River eventually receives the majority of the surface water from this Basin. On the other hand, the Green River Basin lies completely within the headwaters of the Green River which has two large reservoirs on the main stream: Fontenelle and Flaming Gorge.

Vegetation/Soils/Agriculture

VEGETATION

Broad vegetation types for the oil shale region have been described by A.W. Kuchler (1975). Table 2-8 provides a summary of acres and percentage of vegetation type. Refer to the Final EIS for the Prototype Oil Shale Leasing

TABLE 2-7

CHARACTERISTICS OF MAJOR RIVERS

Chacteristics	Upper Green At Fontenelle Reservoir, Utah	Lower Green[a] Near Green River, Utah	Yampa Near Maybell, Colorado	White At Mouth Near Ouray, Utah	Duchesne At Mouth Near Randlett, Utah
Period of Record (yr)	18	81	64	6	38
Drainage Area (mi^2)	4,280	44,850	3,410	5,120	4,247
Average Annual Flow (ac-ft)	1,083,800	4,563,000	1,122,000	479,600	473,500
Maximum Daily Flow (cfs)	19,400	68,100	17,900	4,260	10,300
Minimum Daily Flow (cfs)	209	255	2.0	1.6	2.2
Average Daily Flow (cfs)	1,494	6,298	1,529	662	557
1980 Sediment Discharge (tons)	ND	10,281,496	651,041	2,046,110	ND
Maximum Sediment Discharge (tons/day)	ND	2,230,000	27,000	286,000	ND
Minimum Sediment Discharge (tons/day)	ND	54	0.55	0.69	ND
1980 Maximum (TDS)[b]	ND	799	ND	702	ND
1980 Minimum (TDS)[b]	ND	214	ND	261	ND

Source: U.S.G.S. Water Resources Data 1980.

Note: ND = No data available; mi^2 = square miles; cfs = cubic feet per second; ac-ft = acre feet.

[a] Numbers for lower Green River reach include inflow of upper Green River.

[b] Total Dissolved Solids (TDS) is the same parameter as salinity predicted by the Colorado River Simulation Model.

TABLE 2-8

VEGETATION TYPES WITHIN OIL SHALE REGION

Type	Sagebrush	Pinyon-Juniper	Desert Shrub	Mountain Shrub	Timber	Cropland
Acres	14,867,500	3,327,800	3,349,900	2,655,900	3,016,200	722,600
Percent of Total Vegetation Types	53	12	12	9	11	3

Source: Kuchler 1975, BLM 1981.

Program (Volume VI, BLM 1973) for a description of the vegetation and species listing according to the classification system of BLM. While localized changes have occurred through human (humanity's) influence, the major vegetation types provide an adequate overview of the oil shale region and are summarized as follows:

Sagebrush covers 14,867,500 acres of the cold desert plateaus of Wyoming and Colorado at the mid-elevations. Soils are generally deep and well-drained in a precipitation zone of from 8 to 14 inches annually. Pinyon-juniper vegetation covers 3,327,800 acres and includes portions of the sagebrush type but generally occupies the higher elevations on shallow, well-drained soils in a precipitation zone of from 12 to 16 inches. The desert shrub type covers 3,349,900 acres and has developed on the lower, shallow soils in a precipitation zone of from 4 to 10 inches. These areas are primarily located between Vernal, Utah, and Rangely, Colorado. The mountain shrub type covers the zone between (and in many cases is mixed with) the pinyon-juniper type and timber type in the southern latitudes and between the sagebrush and timber vegetation types in the northern latitudes; it comprises 2,655,900 acres. Soils are generally deep and precipitation ranges from 14 to 20 inches. The timbered areas, 3,016,200 acres, can include Douglas fir forests in the north, western spruce fir in the Colorado Piceance Basin and the pine fir forest in the southern area in Utah. This type is not continuous, as the trees can consist of pockets or islands along with aspen patches located side by side or intermixed. The areas are also interspersed with mountain brush or with large areas of oak brush in Colorado. Soils are highly variable depending upon elevation, slope and aspect. Precipitation ranges from 18 inches at the lower elevations to 45 inches at the higher mountain ranges.

Threatened or Endangered Species

Threatened or endangered plant species are listed according to category (also in the Prototype EIS, BLM 1973). Federal listings are threatened or endangered, which place the species under the protection of the U.S. Department of the Interior, Fish & Wildlife Service. An additional listing is candidate, defined "as having information insufficient to determine status of threatened or endangered at the present time."

Utah, Wyoming, and Colorado have not enacted state statutes to protect plant species lists in the three categories, although Colorado does have a state statute protecting the state flower, the columbine.

The only federally listed species in the oil shale region occur in Colorado and Utah. The hookless cactus, Sclerocatus glaucus is listed as threatened in Colorado and Utah. The clay phacelia, Phacelia argillacea, is listed as endangered in Utah (BLM 1982; Welch 1979). The oil shale area of Wyoming does not contain any federally listed threatened or endangered species (Dorn 1980; BLM 1982e). A listing of candidate species for the oil shale region may be obtained from the BLM Division of Environmental Impact Statement Services in Denver, Colorado.

SOILS

The oil shale region includes a complex combination of soils due to the wide variation of geologic, topographic, climatic, and vegetative features, which creates a wide variety but a repetitive distribution of soils.

Detailed soil survey information is available for approximately 30 percent of the oil shale region. General soil maps, prepared by the Soil Conservation Service (USDA) are available for the entire area at local conservation district offices in Vernal, Utah; Craig, Colorado; and Rock Springs, Wyoming. Additional soil survey information and soil maps are presented in Volume VI of the Final EIS for the Prototype Oil Shale Leasing Program (BLM 1973).

The soils are highly variable in depth, texture, stoniness, chemical properties, moisture regimes and temperature. This variability of characteristics implies a wide variation in drainage, permeability, erodibility, inherent fertility, water-holding capacity, and other soil properties important to the reclamation and revegetation of disturbed lands.

Five major soil areas that correspond to soil types occur in the oil shale region; following are brief descriptions of each:

Light-Colored Soils of the Arid Areas

This soil area comprises the major portion of the study area, including the Uinta Basin in Utah, Washakie Basin in Wyoming, and the Piceance Basin in Colorado. These soils occupy low areas in a climatic setting ranging from 4 to 8 inches of average annual precipitation and within an average 110- to 125-day frost-free season.

Included in this area are deep, loamy, alluvial soils on the nearly level to sloping terraces and floodplains of the White, Green, and Duchesne rivers and the tributary narrow, elongated, intermittent drainageways. These soils are forming in mixed, loamy alluvium derived from sedimentary rock, are the most productive in the area, and are used for grazing and irrigated cropland. Alfalfa, meadow hay, small grains, and corn are the main crops.

Shallow, Steep-Sloping Soils on Consolidated Upland Materials and Badlands

These soils are closely associated with the light-colored soils of the arid areas and are in a setting having an average annual precipitation ranging from 7 to 18 inches with an average of 90 to 125 frost-free days. They are predominantly shallow and well-drained, alkaline to moderately alkaline, stoney, and loamy; they are located on moderately steep to very steep sideslopes and escarpments bordering drainageways, including foothills and steep mountain sideslopes that border the oil shale basins in all three states.

These soils are very sparsely vegetated and are subject to high surface water runoff and erosion hazard (natural erosion).

Moderately Dark-Colored Soils of the Semi-Arid Areas

Soils of this area are intermediate between the light-colored soils of the arid areas and the dark-colored soils of the more moist mountains and foothills areas. They are in a climatic setting with an average annual precipitation ranging from 8 to 14 inches with 90 to 125 frost-free days. These are predominantly moderately deep and shallow, well-drained, neutral to moderately alkaline, and loamy soils located on gently sloping to moderately steep plateaus, sideslopes, convex ridges, and hills.

Included are areas of deep alluvial soils on nearly level to gently sloping terraces and floodplains of intermittent streams that support a more dense vegetative cover. Erosion hazard is slight to moderate. Soils of this type are located at mid-elevations between the lower basins and mountains.

Dark-Colored Soils of the Sub-Humid Areas

This soil area lies adjacent to the forested, mountainous areas and makes up a small part of the oil shale region, roughly located in that portion parallel to the common border of Utah, Wyoming, and Colorado. Precipitation ranges between 16 and 24 inches annually with an average frost-free period of from 90 to 110 days. Erosion hazard is moderate to high depending upon slope and elevation. These are mainly moderately deep and deep, well-drained, slightly acid to slightly alkaline, sandy loam and loamy soils located on sloping to steep plateaus, foothills, and mountain sideslopes.

Soils of the Cool to Cold Forested Areas

Soils of this area occur on foothills and mountainous topography and make up a small part of the area. They are associated with the Uinta mountain range and include some isolated mountains of the desert area. Average annual precipitation ranges from 18 to 45 inches with a frost-free period of 50 to 85 days. Soils are subject to landslides and moderate to high erosion hazards.

These are mainly shallow and moderately deep, moderately acid to neutral, loamy soils with varying amounts of coarse fragments on moderately sloping to steep-sloping mountain sideslopes.

AGRICULTURE

Cropland cultivation within the three states of the oil shale region is largely in support of the livestock industry. Where lands are irrigated, crops are generally native hay, alfalfa, or forage for sheep and cattle, while the livestock are off the range during the winter months. Except for localized areas, cultivation and irrigation take place on alluvial soils along valley bottoms and major drainages. Acres and percentage of land used for agricultural purposes within the oil shale region are displayed by state in Table 2-9.

TABLE 2-9

PRIVATE CROPLAND AND PASTURE LAND WITHIN OIL SHALE REGION

Type	Colorado	Utah	Wyoming	Total for Oil Shale Region
Irrigated Cropland and Pasture Land (acres)	98,800	178,400	18,100	295,300
Percent*	34	60	6	100
Non-irrigated Cropland and Pasture Land (acres)	87,100	277,700	62,500	427,300
Percent*	20	65	15	100

Source: BLM 1982c; Utah Department of Agriculture 1981.

*Of total amount of agricultural land located within oil shale region by state.

The major contribution to the economy of the states' agricultural industry is from livestock grazing on Public Lands. Table 2-10 gives a comparison, by state, of livestock numbers and forage produced in the oil shale region.

Wildlife

For purposes of this EIS, the wildlife study area in the oil shale region includes: Moffat, Rio Blanco, Garfield, and Mesa counties in Colorado; Grand, Uintah, Carbon, and Duchesne counties in Utah; and Lincoln, Sublette, Sweetwater, and Uinta counties in Wyoming.

Wildlife resources are of considerable economical and recreational importance in the oil shale region, which contains an estimated 7 species of big game (mule deer, elk (Wapiti), moose, pronghorn, bighorn sheep, black bear, and cougar), 3 species of small game mammals (cottontail rabbit, snowshoe hare and pine squirrel), 8 species of upland game birds (ring-necked pheasant, sage grouse, bluegrouse, mourning dove, sharptailed grouse, chukar, Gambel's quail and ptarmigan), 27 species of migratory waterfowl, 16 species of furbearers, 21 species of nongame mammals, 28 species of raptors, and at least 250 species of nongame birds. In addition, several feral horse herds range over the region, totaling an estimated 4,275 head (BLM 1982b, c, d, e, and f). Complete lists of wildlife species occurring in the oil shale region may be obtained from the wildlife management agencies of each state.

There have been over 300 species of wildlife documented as occurring in the oil shale region of Colorado (Colorado Division of Wildlife 1977), while Utah reports about 391 species (Utah Division of Wildlife Resources 1981c), and Wyoming indicates about 324 species (Wyoming Game and Fish Department 1977a). All species of wildlife, game as well as nongame, contribute to an intense public interest in the oil shale region's wild animals, because they provide numerous opportunities for hunting, fishing, observation, and photography.

The oil shale region encompasses a tremendous variety of wildlife habitats because of the range in altitude found here (approximately 4,800 feet at the confluence of the White and Green rivers to almost 12,000 feet in the Uinta Mountains). These habitats vary from critical big game winter ranges to sagegrouse strutting grounds; some, or all of which, are found in areas that might be disturbed by oil shale development.

Numbers of mule deer in this area have not yet completely recovered from the severe declines of the late 1960's and 1970's; however, they are still the most important big game animal in terms of total numbers. Present estimates of the mule deer population indicate that herd numbers are stable to slightly increasing.

Elk populations are increasing in all three states and are probably at the highest levels they have ever been. Pronghorn are found in all three states, with the largest numbers occurring in Wyoming; their population is thought to be stable to slightly increasing within the oil shale region.

TABLE 2-10

AUMs OF FORAGE AND LIVESTOCK NUMBERS WITHIN OIL SHALE REGION

	Colorado	Utah	Wyoming	Total for Oil Shale Region
Livestock	98,440	74,500	130,550	303,490
Percent	32	25	43	100
Forage(AUMs)*	270,800	512,600	584,300	1,367,700
Percent	20	37	43	100

Source: Utah Department of Agriculture 1981; BLM 1982c; BLM 1981.

*AUM's = Animal Unit Months; Other than forage produced on private land (see Table 2-9).

Moose are found only in the Utah and Wyoming portions of the oil shale region (Utah Division of Wildlife Resources 1977; Wyoming Game and Fish Department 1977). Population of these animals appear to be expanding in favorable habitats. Small populations of bighorn sheep are found in Colorado and Utah, with populations apparently in a stable condition; some limited hunting occurs on these trophy species.

Two large predators, the black bear and cougar, are common in the oil shale region. Estimates by the various state wildlife management agencies indicate that present populations of these two species are stable. Hunting of 18 species of varmints and furbearers occurs in all three states, with detailed harvest data collected only by the Colorado Division of Wildlife. In addition to furnishing hunting, 15 species are also trapped.

There are 11 upland and small game species that are legally hunted in the three-state area, and populations are estimated to be stable at the present time. The oil shale region cannot be classified as a high waterfowl production area, but enough resident waterfowl species, plus some migrants, furnish hunting for persons who enjoy pursuing ducks and geese.

There are an estimated 28 species of raptorial birds known or suspected to inhabit the oil shale region; because of high public interest, special consideration must be given to their protection, especially during the courting, breeding, and nesting seasons. No density information presently exists for these species in the oil shale region. In addition to raptors, there are at least 259 species of small nongame birds also found here.

Fishery habitat in the three-state region includes more than 36,000 acres of natural lakes, 275,000 acres of reservoirs, and about 9,000 miles of fishing streams (BLM 1973).

In addition to consumptive uses of wildlife, a large number of people participate in photographing, bird-watching, and otherwise enjoying wildlife (Colorado Division of Wildlife 1977; Allred 1976; Wyoming Game and Fish Department 1978).

THREATENED OR ENDANGERED SPECIES

There are seven species or subspecies of wildlife known to occur in the oil shale region which are federally listed as endangered or threatened. Some state listed species or species of special concern are also found here (Colorado Division of Wildlife 1977, Utah Division of Wildlife Resources 1981; Wyoming Game and Fish Department 1977). Table 2-11 lists some of these species and their status.

TABLE 2-11

THREATENED OR ENDANGERED WILDLIFE SPECIES WITHIN OIL SHALE REGION

Common Name	Scientific Name	Status
Black-footed Ferret	Mustela nigripes	1
Peregrine Falcon	Falco peregrinus anatum	1
Whooping Crane	Grus americana	1
Bald Eagle	Haliaeetus leucoeephalus	1
Humpback Chub	Gila cypha	1
Colorado Squawfish	Ptychocheilus lucius	1
Bonytail Chub	Gila elegans	1
Spotted Bat	Euderma maculatum	2
Prairie Falcon	Falco mexicanus	2
Razorback Sucker	Xyrauchen texanus	2
American Osprey	Pandion haliaetus	3
Bluehead Sucker	Catastomus discobolus	3
Dusky Darter	Percina sciera	3
Colorado River Cutthroat Trout	Salmo clarki pleuriticus	3
Western Burrowing Owl	speotyto cunicularia	3

Source: BLM 1973.

1 = Endangered Species; Federal listing.

2 = Species likely to become endangered.

3 = Undetermined status.

Recreation Resources

The three general categories of recreation which could be affected by the proposed action are: (1) dispersed outdoor recreation opportunities (impromptu camping and day use activities); (2) developed, intensively used, outdoor recreation areas and sites; and (3) urban recreation.

Due to the high percentage of federal land, most of the land within the region is available for dispersed outdoor recreation opportunities. The various dispersed recreation opportunities which are most popular in the oil shale region include fishing, sightseeing by automobile, camping, and big game hunting. Other activities include backpacking, river running, skiing, snowmobiling, winter sports, small game hunting, and off-road vehicle use.

Developed, intensively used, outdoor recreation areas and sites include national parks and monuments, recreation areas, national forests, national wildlife refuges, and state parks and recreation areas. Lakes, rivers, and rock outcrop areas of all jurisdiction, including private facilities, are also used by the public for recreation.

Studies by the Utah Department of Natural Resources have shown that most weekend recreational use by local inhabitants in Utah takes place within an approximate driving time of 2 hours from communities (BLM 1981). Based on these studies, a 2-hour driving time Secondary Zone of Influence was calculated based on communities within living distance of the oil shale region. Within this 2-hour Secondary Zone of Influence, there are six national parks and monuments, 2 national recreation areas, 14 national forests, and 6 national wildlife refuges. There are 168 wilderness units of all categories in the region of influence, many of which attract heavier than average primitive recreation use. In addition, the BLM and FS administer many areas which are more intensively used by the public for various recreational pursuits.

The states of Wyoming, Utah, and Colorado administer many state parks, recreation areas, and fishing areas within the approximate 2-hour driving time. In addition, there are numerous places where people recreate which are not within the above jurisdictions.

There are 32 segments of rivers of national significance within the oil shale region; they are currently on the Nationwide Rivers Inventory, Phase I list, as developed by the National Park Service following the initial work of the Heritage Conservation and Recreation Service (U.S. NPS 1982; U.S. HCRS 1980). Status on this list indicates that the river segments possess values which have been identified as being nationally significant; however, they are not afforded protection status.

Four of the river segments on the list are within the area of oil shale deposits --- the Green River, Range Creek, and the White River (all in the Uinta Basin in Utah), and the east end of the Fontenelle Creek segment in Wyoming.

There may be National Natural Landmarks and BLM Areas of Critical Environmental Concern (ACEC's) within the Zone of Influence, which would be identified later in the more specific assessments to be prepared for developing specific leases.

There are six trails in the National Trails System within the Secondary Zone of Influence. The Continental Divide Trail is designated as a scenic trail. Three are historic trails--the Mormon Pioneer Trail, the Oregon Trail (both designated), and the Dominguez-Escalante Trail, which has been recommended to Congress for addition to the National Trails System. The last two are short recreation trails, the 6-mile Cascade Nature Trail in Utah, and the 11-mile Crag Crest Trail in Colorado.

The communities in which populations are likely to expand have some type of urban recreation facilities and community park and picnic areas provided either by private enterprise or the municipalities. The facilities are of the type usually found in small towns.

Wilderness

Table 2-12 lists the various categories of federal wilderness units within the affected area under the authority of the Wilderness Act of 1964 (Public Law 88-577), the Federal Land Policy and Management Act of 1976 (Public Law 94-579), Public Law 94-567 (October 20, 1976), and Public Law 95-560 December 22, 1980).

By 1990, it would be expected that the vast majority of each agency's wilderness units recommended for study or further planning, or are recommended to Congress for wilderness designation, would be classified as either wilderness or non-wilderness. Thus, the numbers of units in Table 2-12 will have changed.

Visual Resources

The visual resources of a region are based upon a set of physical characteristics which establish a scenic quality as visually perceived by the viewer. Additionally, how the viewer feels about visually perceptible change within the area, the numbers of viewers, and how distant the viewers are from what is being viewed, comprise what is commonly referred to as the "visual resources." The "sense" of the region in visual resource terms is present in an individual's mind, either based upon first-hand observation of what the physical characteristics are in terms of landform, vegetation, and visible man-caused modification, or upon an impression created in a person's mind through secondary input, such as movies, reading, or other forms of education.

The actual physical characteristics of a region can best be described by dividing the landscape into homogeneous units termed "physiographic provinces"; three are located in the oil shale region (Fenneman 1931). The Wyoming Basin province (approximately 40 percent of the region) occurs in central and south-central Wyoming and is an interruption of the Rocky Mountains. The Middle Rocky Mountains province (approximately 20 percent of

TABLE 2-12

FEDERAL WILDERNESS UNITS WITHIN OIL SHALE REGION

Administering Agency	Categories of Wilderness Units	Number of Units Colorado	Utah	Wyoming	Total
National Park Service	Wilderness Areas	1	0	0	1
	Recommendation before Congress for designation as Wilderness	2	4	0	6
Forest Service	Wilderness Areas	9	1	3	13
	Congressionally designated study areas and wilderness (Recommendations Rare II)	5	8	7	20
	Rare II further planning areas	2	4	2	8
Bureau of Land Management	Wilderness Study Areas (WSA)	47[a]	22[a]	24[b]	93
	Wilderness Study Areas not recommended for WSA status; under appeal for reconsideration	1	10	1	12
	Wilderness Study Areas under appeal in whole or part	7	2[c]	6[c]	15
Total Wilderness Units of All Types		74	51	43	168

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[a] Of these, one is within the areas where oil shale deposits occur and which are studied for leasing under the proposed regulations; the rest are within the Secondary Zone of Influence.

[b] Six are within the area where oil shale deposits occur and which are being studied for leasing under the proposed regulations. Two of these are under appeal as of August 1982.

[c] These are part of the WSA total.

the region) includes the Wasatch Mountains and the Uinta Mountains in the western portion of the region. The Colorado Plateau province (approximately 40 percent of the region) occurs in the southern portion of the region in eastern Utah and northwestern Colorado.

Structures in the landscape are varied and include linear systems, such as above and below ground pipelines, fences, roads, and transmission lines; and point systems, such as oil and gas storage and pumping facilities, ranch buildings and other improvements, reservoirs, townsites, and electrical-generating facilities. These structures create varying degrees of contrast depending on the degree of form, line, color, and texture differences created between the projects and the surrounding landscape.

The above mentioned physical characteristics have been rated for Class A, B, or C, Scenic Quality, combined with a sensitivity rating and distance zone to create a Visual Resource Management (VRM) class for each portion of the oil shale region.

Analysis indicates that all five VRM Classes occur within the oil shale region, with general disturbance and areas covered within the region as follows:

- Class I, covering approximately 4 percent of the region, occurs along the crest of the Uinta Mountains, Desolation Canyon south along the Green River, Dinosaur National Monument, and the Red Desert.

- Class II, covering approximately 18 percent of the area, occurs primarily along lower portions of the river drainages, such as the Green, Yampa, White, and portions of the Duchesne rivers, a number of Uinta Mountain drainages, Flaming Gorge National Recreation Area, and along U.S. Highway 40 through the Wasatch Mountains.

- Class III, covering approximately 26 percent of the area, and Class IV, covering another 52 percent, tend to be located over most of the remaining portions of the oil shale region, where scenic quality tends to be lower and viewer sensitivity toward change tends to be less.

- Class V, covering less than 1 percent of the region, tends to be located where mineral development activities occur, such as oil and gas fields, coal mines, or existing oil shale project areas.

For purposes of comparison, all lands, regardless of ownership, have been generally classified using the BLM VRM System, recognizing that lands within National Forests would be managed under the Visual Management System. (Refer to Appendix 2 for a description of the two systems and associated definitions of terms).

Cultural Resources

The area that could be affected by the federal oil shale leasing program shows evidence of human activities from approximately 12,000 years ago to the present. Within this time span, population patterns have fluctuated according to environmental and social changes, and have been assigned by prehistorians to several culture periods. Variations, identified by prehistorians as culture areas, also occur among the geographic areas.

Five broad culture periods are represented in the oil shale region. (1) The Paleo-Indian period occurred approximately 8,000 to 12,000 years ago. Sites from this period are characterized by fluted projectile points and have been located in eastern Utah near Duchesne, Roosevelt, and Moab and in western Colorado on the Uncompahgre Plateau and near Grand Junction. (2) The Archaic period occurred approximately 1,000 to 8,000 years ago. Numerous campsites representing this period occur throughout the oil shale region. (3) The Horticultural period occurred approximately 800 to 1,000 years ago, during which local variants of the Fremont culture occupied the oil shale region (Madsen 1979; Marwitt 1970). In some parts of the oil shale region, the Archaic lifestyle probably persisted contemporaneously with the Fremont occupation. (4) The Proto-Historic period occurred in the region from about A.D. 1200 to A.D. 1776. In northeastern Utah and the western Wyoming Basin, the Fremont people were replaced by hunters from the high plains. The horse was introduced into the region in the late 1600's or early 1700's. (5) The Historic period began in the oil shale region with the Dominquez-Escalante Expedition in 1776. Euro-American activities in the oil shale region may be divided into four categories: exploration and trapping, agricultural occupations, communications, and mining.

The archaeology of west-central Colorado has been summarized by Kane (1973). Approximately 7 percent of the oil shale region in Colorado has been surveyed for cultural resources. Over 460 sites and isolated finds have been located and recorded. Predominant site types include campsites, chipped and ground stone scatters, and historic architectural sites.

Historic resources in the Colorado oil shale region include the Overland, Cherokee, and Escalante trails; stage stations; and sheepherder camps. Athearn (1976) and Hafen (1965) identified fur trading, mining, and ranching as the major activities.

The archaeology of the Great Basin culture area, which includes the western part of the oil shale region, has been summarized by Aikens (1978) and Jennings (1978). Approximately 10 percent of the oil shale region in Utah has been surveyed, with over 900 sites identified (Jones and Mackay 1980). Gilsonite mining was an important activity after 1900 and many remnants of this industry have been located in the Utah oil shale region (Bender 1971).

The oil shale region in Wyoming is viewed by some as a frontier between the Plains and Great Basin culture areas. Previous work by Kainer (1981) and Larson (n.d.) indicate that prehistoric settlement was most influenced by water resources and sand dune environments. Approximately 10 percent of the oil shale region in Wyoming has been surveyed and over 3,000 sites have been recorded (Decker 1982).

Historic resources include remnants of the Overland, Immigrant, and Cherokee trails, and the Pony Express Route. The tie hack campsites are prevalent in the Uinta Mountains (Decker 1982).

Mineral Resources

The developmental activity in the oil shale region will affect, by consumption, three types of mineral resources: the source rocks containing the shale oil, aggregate, and evaporite minerals.

As described in the first part of this chapter, there are approximately 1,705 billion barrels of recoverable shale oil in the oil shale region.

Aggregate in the oil shale region is found in two forms: in the hard crystalline rocks of the Uinta and Rocky Mountains and in alluvium along large and small rivers. Soundness and reactivity of the aggregate is variable; however, ample supplies exist. Processing of the aggregate will supply sufficient amounts of concrete aggregate and mortar sand as well as large amounts of materials suitable for subgrade.

Evaporite minerals (soda ash, nahcolite, dawsonite) in the oil shale region are found in close association with oil shale source rocks. Mining of these source rocks will encounter these minerals which are useful to industry and, therefore, have economic value.

Paleontology

Based upon the geological processes that developed the Uinta Basin, there is a high probability that fossil-bearing strata could be encountered at any place in the oil shale region. Several formations that are rich in fossils are found throughout the oil shale region. The best known is the Morrison Formation, which outcrops in Dinosaur National Monument and extends south within the oil shale region. In addition, several insect fossils are found throughout the Piceance Creek Basin.

Transportation Networks

Many roadways would be used in the Colorado, Utah, and Wyoming region to transport supplies, products, and people associated with oil shale development. An estimated 1,100 miles of roadways would be directly affected. Of this amount, 17.1 percent, or 188 miles, are presently considered deficient either structurally or due to existing traffic exceeding initial design capacities. The greatest deficiencies exist within Colorado where 48 percent of the affected roadways are presently considered deficient. (Uintah Basin Transportation Study 1980; Akins 1982; Tennoy 1982). Additional data on the location, design capacity, traffic load, and surface condition may be obtained from each of the state highway departments.

CHAPTER 3
ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

This chapter discusses the environmental consequences (impacts) resulting from the implementation of the proposed action and alternatives.

Prior to a discussion of environmental consequences, certain assumptions and procedures which were used in the analysis process of determining environmental impacts are explained, including a discussion on:

1. Analysis Points - time periods when impacts were analyzed (1990 and 2000).
2. Analysis Levels - assumed levels of activities (low and high) analyzed for potential impacts.
3. Analysis Procedures - coordinations of analysis points and levels which were analyzed in detail.
4. Assumptions - specific assumptions which were developed in order to analyze the proposed action and No-Action Alternative.

Analysis Points

Two periods, 1990 and 2000, were selected to analyze impacts. These were selected to provide a range of impacts over time. The first one, 1990, was based on the expectation that some of the current oil shale projects that are being developed on private land and on the 1974 prototype leases would be in operation. The 2000 date was selected based on the following expectations: (1) The proposed action would be implemented with the first lease sale in 1984, and (2) projects on new federal leasing that may occur as a result of implementing the proposed action would be in operation.

Analysis Levels

Since the proposed action is the implementation of a federal oil shale management program and not a specific proposal to develop oil shale, an assumed level of possible production was developed on which to base the impact analysis. If implemented, the proposed action would place procedures into effect that would not only allow the leasing and development of oil shale reserves, but would also control the level at which leasing and production could occur. Therefore, two levels (low and high) of possible activity were used as a basis for impact assessment and were developed to attempt to predict a range of impacts from least to worst case that could possibly result from implementing the proposed action. The reader of this environmental impact statement (EIS) should keep in mind that even though the EIS makes predictions of impacts, implementation of the proposed action does not ensure that any of these impacts would occur, only that they or similar impacts may occur if additional oil shale reserves are leased.

The low level assumes unfavorable economics for commercial development of oil shale, limited governmental subsidies (i.e., loan or price guarantees), utilization of existing technologies (no major technological breakthroughs), financing uncertainties in the form of high interest rates from private sources, and stable international situations favoring continued oil imports at present or even higher levels. The recent decision by Exxon Corporation on the Colony Oil Shale Project in Colorado reflects a more probable climate for the low-level situation.

The high level assumes favorable economics for oil shale development (oil shale production costs and market prices competitive with oil in domestic and world markets), more favorable climate for governmental subsidies, if needed, improved technological processes, long-term interest rates that would encourage private investments and less stability in international relations, placing more priority on domestic development for national security reasons.

Analysis Procedures

When the analysis points and levels were applied to the proposed and no-action situations, a series of combinations were formed (see Figure 3-1).

The No-Action Alternative consists of baseline conditions in the environment along with potential projects (non-federal oil shale and non-oil shale) which were predicted to be implemented during the analysis points (1990 or 2000) and according to the analysis levels (low and high). Included were oil shale projects which would be developed on private and state lands, the existing prototype oil shale leases issued in 1974, and the prototype oil shale lease proposed for early 1984.

The analysis of the No-Action Alternative is cumulative, including the impact of all the proposed activities at each analysis point and for each level. The oil shale portion of the No-Action Alternative was not analyzed separately.

In order to analyze the proposed action, an assumed level of development that could occur if the proposed federal oil shale management program was initiated was added to the baseline situation or No-Action Alternative. The first step in the analysis of the proposed action was to determine what the impact would be for the assumed development under the proposed program without considering any other projects. The second step was an analysis of the cumulative impact of the proposed program when combined with the impact of the other projects predicted to be occurring (No-Action Alternative).

Some of the analysis combinations were not significantly different from others. The no-action and the assumed proposed action situations in 1990, low level, did not show significantly different impacts, because most of the projected new oil shale projects on federal lands would not have begun operation or production. History has shown that it requires a minimum of 10 years to bring a lease into production. In addition, the No-Action Alternative in 2000 (low level) and the No-Action Alternative and assumed proposed action situation in 1990 (high level) were not appreciably different in terms of predicted impacts. This was due, in part, to the different baseline conditions in 2000 versus 1990, compensating for the different levels

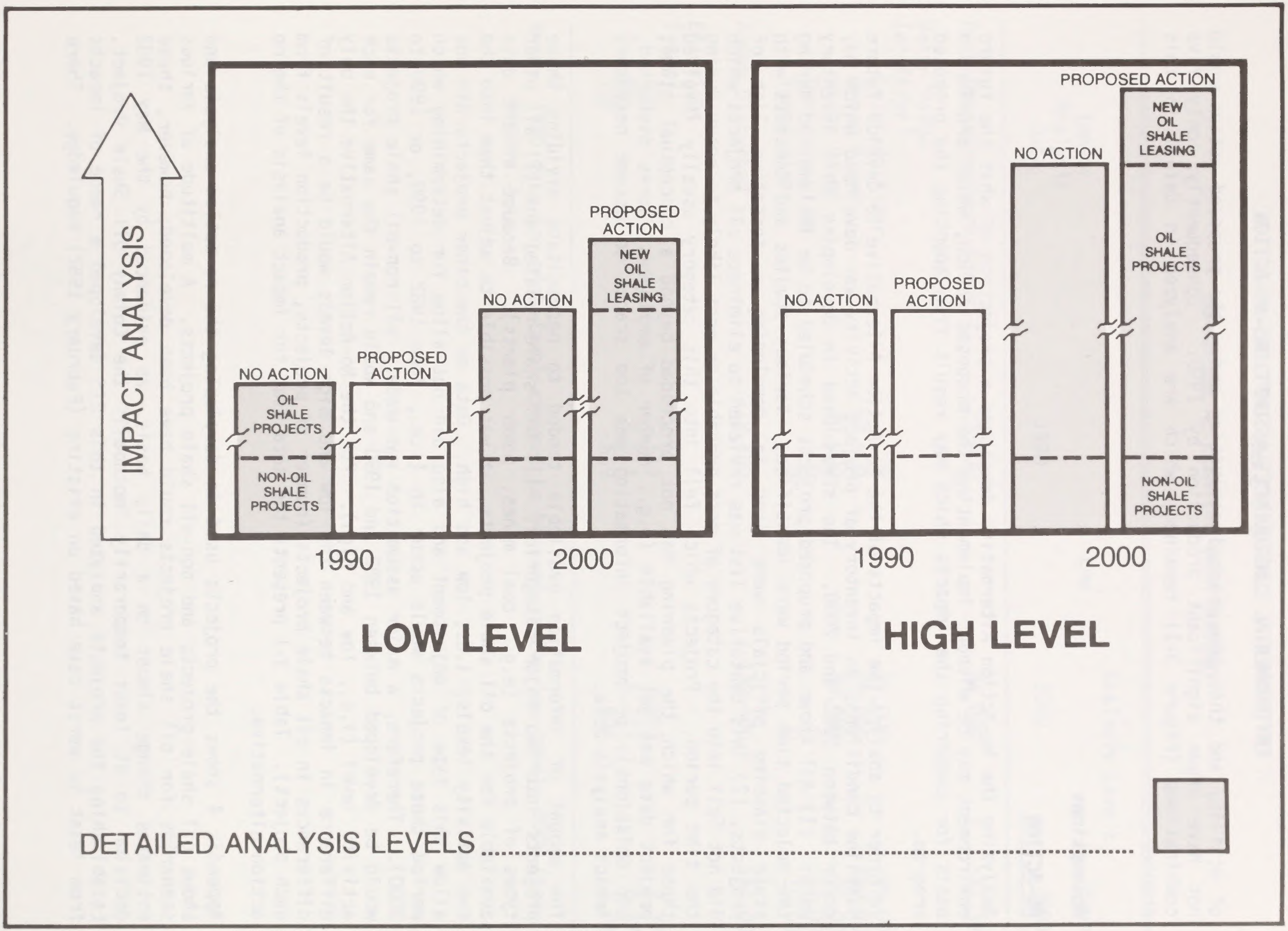

FIGURE 3-1 ANALYSIS COMBINATIONS

of activity and that the assumed activities under the proposed action would not have begun significant production by 1990. Consequently, only five combinations (Figure 3-1) remained, which are analyzed in detail in this chapter.

Assumptions

NO-ACTION

Analyzing the No-Action Alternative developed a projection of what the future environment may be without implementing the proposed action, which provided a basis for comparing the impacts which may result from adopting the proposed program.

In order to analyze the impacts of the No-Action Alternative to develop future baseline conditions, an inventory of project activity was developed which may occur between 1982 and 2000. The steps used in developing this inventory were: (1) All known and proposed projects scheduled to be implemented during the selected time period were identified. Various studies and contacts with state planning officials were used in developing a tentative list of projects. (2) This tentative list was reviewed to eliminate all projects which did not fall into the category of most probable or most likely to occur during the time period. Projects which fell into this category usually involved those for which the planning had not proceeded beyond a conceptual stage; project data was not available (e.g., number of employees, acres disturbed, air emissions); or project information was too scarce to assume necessary impact analysis data.

The amount of information available tended to necessitate dividing these projects into two major categories: (1) Oil shale-related and (2) all other types of projects (e.g., coal mines, power plants). Because of the data available for the oil shale projects, it was possible to adjust them into the two activity levels; i.e., low and high. Data on the other projects did not allow this type of adjustment and also did not allow for determining which period those projects would occur in (i.e., from 1982 to 1990, or 1990 to 2000). Therefore, a major assumption was made: all non-oil shale projects would be developed between 1982 and 1990 and would remain the same for each activity level (i.e., low and high). For the No-Action Alternative the only difference in impacts between the low and high levels would be a result of differences in oil shale projects (number of projects, production levels from each project). Table 3-1 presents the data used for impact analysis of the no action alternative.

Appendix 4 shows the projects used in developing the no-action analysis and shows oil shale projects and non-oil shale projects. A multitude of various scenarios for oil shale projects could have been developed; however, these estimates change almost on a daily basis, as evidenced by the May 1982 decision to at least temporarily "mothball" the Colony Oil Shale Project. Establishing the projects analyzed in this EIS developed a range of impacts from least to worst case based on existing (February 1982) knowledge. There

TABLE 3-1

NO-ACTION ALTERNATIVE DATA SUMMARY

Impact Analysis Data	Analysis Levels		
	Low		High
	1990	2000	2000
Peak Operation Work Force	23,900	34,090	51,325
Water Usage (ac-ft/yr)			
Colorado River	0	22,000	39,000
Green River	67,000	89,000	159,000
White River	20,000	26,000	96,000
Duchesne River	0	0	12,000
Yampa River	0	0	16,000
Acres Disturbed	112,600	139,600	167,000
Emissions (ug/m^3)			
SO_2	1,513	1,963	2,778
NO_x	2,614	4,121	6,570
TSP	669	934	1,359

Note: 1990 data for high level assumed to be same as for low level, 2000 (see Figure 3-1).

is no attempt made by this EIS to state what the exact impact may be at any time period, but rather it provides the decision maker with a range of impacts that may reasonably be expected to occur.

Another major assumption which had to be made was: impacts would be analyzed at only the selected analysis points (i.e., 1990 and 2000), and the impacts would be based on the operational level of the projects, not the construction phase. It is recognized that construction of these projects would be occurring throughout the time period. However, there was neither specific nor accurate data (i.e., number of employees, acreage disturbed) to present a meaningful analysis of construction impacts. Therefore, the data used for these projects was operational, and it was assumed that these projects were in operation at the selected analysis points.

PROPOSED ACTION

As stated in Chapter 1, the proposed action is the adoption of regulations for a federal oil shale management program.

Therefore, adoption of the proposed regulations would not automatically cause impacts but could result in impacts if leases were issued. In order to analyze the impacts of the proposed program, it was necessary to develop a number of assumptions.

Actual locations of leases that may result from the proposed action are impossible to predict at this stage of the process. As described in Chapter 1, the proposed program includes National Environmental Policy Act (NEPA) compliance procedures at various stages which would deal with impacts of leasing specific areas. The program is designed to develop oil shale in such a manner to minimize impacts to the degree possible.

Hypothetical locations, selected for this EIS in order to analyze impacts, are in Colorado, Utah, and Wyoming, and were based on known oil shale resources and areas where private development is either occurring or projected to occur. Type of mining and project data were assumed based on project design data for projects under construction on existing federal prototype oil shale leases or on private land.

Two locations involving two different techniques were assumed in the Piceance Basin area of Colorado:

1) Open pit mining for up to 140,000 bbl/day production; long life from 30 to 50 years; located on federal lands that are best suited for open pit mining, (i.e., where oil shale is closest to surface); water taken from Colorado River:

2) Underground room-and-pillar mining with modified in situ retorting (MIS) for up to 140,000 bbl/day production; large underground equipment used; water from Colorado River; located in center of basin where shale is richest; production assumed with 40,000 bbl/day from aboveground retorts and 100,000 bbl/day from MIS (will be best state-of-the-art by 2000).

One location was assumed in the Uinta Basin area of Utah:

1) Underground room-and-pillar mining from 40,000 to 80,000 bbl/day production; spent shale disposal, aboveground; new roads; product and water pipelines; power, etc; water from Green River.

One location was assumed in the Green River Basin of Wyoming. All other assumptions were the same as for the Utah area.

Table 3-2 presents the assumed data that was used for the impact analysis of the proposed action. Appendix 4 presents the amount of production that was assumed for each of the areas, analysis levels, and analysis points.

GENERAL IMPACTS

Some subject areas did not lend themselves to an impact analysis discussion by proposed action, No-Action Alternative, analysis points or levels. Predicting impact differences between levels and alternatives was not possible at the program level of analysis. The impact discussion contained in this section would apply to any of the alternatives and levels with only minor differences as a result of changes over time and differences between levels.

Ground Water

Recovery and processing of oil shale would involve several major aspects of ground water management. Mining and underground retorting require a totally unsaturated environment. Little ground water is present in the Utah Uintah Basin. In deeper deposits, particularly in the central parts of the Piceance Creek and Green River Basins, large quantities of ground water, possibly much more than can be consumed, must be removed and probably returned to adjacent parts of equivalent aquifers, sufficiently distant to prevent recycling. Water quality will vary and injection into aquifers containing similar or worse quality water would prevent deterioration of quality.

Estimates of effects to ground water can vary by several magnitudes, depending on location, size and number of mines, type of mining, and whether or not retorting would be done underground. In addition, various retorting, upgrading, and spent shale disposal methods consume different quantities of water. Since this EIS does not analyze specific methods of oil shale processing, impacts to ground water for the proposed action and No-Action Alternative cannot be specifically analyzed and thus are not presented. However, a qualitative discussion of these effects is possible and is presented below.

In an example of an attempt to quantify the hydrologic effects of oil shale development in the Piceance Creek Basin, the U.S. Geologic Survey (Weeks, et al. 1974) calculated that two hypothetical mines, one open pit and the other underground, producing a total of 100,000 barrels of shale oil per day, would dewater about 20,000 ac-ft/yr for 30 years. Most of this water would come from oil shale horizons and some would come from those zones below the shale horizons. This is 2 to 20 percent of the estimated volume of ground water in

TABLE 3-2

PROPOSED ACTION DATA SUMMARY

Impact Analysis Data	Analysis Levels Low 2000	High 2000
Production (bbl/day)	120,000	400,000
Peak Operating Work Force	5,040	16,500
Water Usage (ac-ft/yr)		
Colorado River	7,000	45,000
Green River	29,000	19,000
White River	0	0
Acres Disturbed	8,500	28,400
Emissions (ug/m^3)		
SO_2	147	496
NO_x	693	2,335
TSP	91	307

Note: 1990 level for high and low assumed to be same as for no-action alternative, since none of assumed federal leases are predicted to be in operation.

basin storage. In these hypothetical cases, the water would be consumed and none would be discharged. The resulting lowering of the water table/piezometric surface would affect about 75 percent of the model area (most of Yellow Creek and Piceance Creek drainage basin), reducing flow in Piceance Creek by 8 cfs, from 15,650 ac-ft/yr to 9,858 ac-ft/yr and increasing dissolved solids. In the affected area, source springs (not perched) would either stop flowing or flow less, and some shallow wells would go dry or have increased pumping lifts.

In addition, a study of the possible effects of shale oil production on water quality in the Piceance Creek Basin by Robson and Saulvier (1981) can be used to indicate the magnitude of possible water quality impacts. They simulated the effects of leaching of in situ spent shale for 60 years after completing operations in two hypothetical mines similar to those previously analyzed by Weeks and others (1975). They concluded that 60 years after completing operations at one of the mines, dissolved solids concentrations in the ground water in a 140-square mile area down-gradient would be increased by 10 mg/l and that dissolved solids concentrations as much as 40,000 mg/l would be produced near the mine. After 60 years of leaching the other mine, they estimated flows in Piceance Creek would be reduced by 15 cfs and concentrations of dissolved solids would increase from 750 to 1,750 mg/l near the mine. In both mines there is the potential for water from the oil shale horizons and those areas below these horizons to mix. This would cause both aquifers to decline in quality. Secondary impacts of oil shale water management will depend on the extent of development. Reduced spring flows would affect stock watering and wildlife and would inhibit fishing and any existing irrigations. Lowered ground water levels would increase pumping lifts in the few wells used for domestic and stock watering purposes. Reduced base flow to streams could improve surface water quality all the way to Mexico.

Health and Safety

The discussion presented in this section is based on information included in An Assessment of Oil Shale Technologies (Office of Technology Assessment 1980).

MINING

The similarity of hard-rock mining to underground shale mining makes it possible to project likely occupational safety risks. During mining, accidents result from rock and roof falls, explosions and fires, bumps and falls, electrocution, heavy mining equipment, and vehicular traffic. Hard-rock mining is a high-risk occupation; fatalities are five times more frequent in the mining and quarry industry than in the manufacturing industry.

The hazard of mine flooding is not unique to oil shale, nor would it be encountered in all oil shale mines. However, it could be severe in mines that are developed within ground water areas. While the mining zones would be dewatered before mining could begin, there could be flooding if the pumps failed.

GENERAL IMPACTS-HEALTH AND SAFETY

While most hazards to oil shale miners would be similar to those experienced by hard-rock workers, some are unique to oil shale. The high temperatures and fires involved in modified in situ processes may expose miners to risks that are not experienced in other underground mining activities.

During oil shale mining, hazardous substances including silica dust would be generated by blasting and drilling. In addition, blasting, raw shale handling and disposal, and other activities at the mine site would produce fugitive dust. Silica-containing dusts are noteworthy because they have been the single greatest health hazard throughout the history of underground mining.

Although few studies have been undertaken on the direct association between oil shale mining in the United States and the incidence of lung disease, there are studies on the prevalence of lung disease in oil shale miners in Estonia (a republic of the Soviet Union). Estonia mined 25 million tons of oil shale in 1973 and has had oil shale operations for several decades. While the results of the Estonian studies are more intriguing than convincing, they do suggest an association between oil shale mining and pulmonary fibrosis - an increase in the amount of fibrous material in the lung. One study also indicated that chronic bronchitis was 2 to 2.5 times more prevalent in 189 Estonian oil shale miners than in a similarly-aged control population.

Studies of occupational diseases among oil shale miners in the United States have been limited because relatively few people have worked in the industry. A study was undertaken involving miners from the oil shale research center at Anvil Points, Colorado, which has operated intermittently since 1946. Eighty-six workers were identified, but only 39 of them had been exposed to oil shale for 1 or more years. Those 39 were compared with 26 other workers from the facility (e.g., office workers, administrators) who had not been directly involved in the mining operations. Results showed a two-fold higher incidence of pneumoconiosis in the oil-shale exposed population. However, the interpretation of these results is complicated by the fact that most of the oil shale miners had previously worked in uranium-vanadium mines or milling operations which are known to be causes of pneumoconiosis. Further evaluation of these populations was not performed because of the age of the workers, their varying levels of exposure, and their limited experience in oil shale mining.

Another area of concern is the possible exposure to carcinogens (polycyclic aromatic hydrocarbons-PAHs) and trace elements that might be produced during mining. A mortality study by the National Institute for Occupational Safety and Health found that the percentage of oil shale workers who had died from colon and respiratory concerns was greater than the percentage in the white male population of Colorado and Utah. Whether oil shale exposure contributed to the higher incidence is unclear, and the rate was not higher than that of the white male population in the United States.

A third potential health hazard to oil shale miners is exposure to excessive noise levels, particularly in underground operations carried out in relatively confined spaces. Noise arises from numerous sources such as booster fans, pneumatic drills, blasting, conveyors, and mining machines. Evidence indicates exposure to noise from a large number of mining machines would produce hearing loss if the exposures exceeded 8 hours per day. Higher short-term noise exposures may occur during blasting. High noise levels are a potential hazard not only to hearing but to the cardiovascular and nervous systems, as well, and pose a safety hazard.

RETORTING AND REFINING

Potential hazards associated with the retorting and upgrading of shale oil include explosions, fire and heat, bumps and falls, electrocution, and handling hot liquids. However, the degree of risk for workers involved in the processing of oil shale and its derivatives would not be expected to be so high as in mining.

Retorting oil shale at high temperatures forms PAH-containing carcinogens, of which, 3.4-benzo(a)pyrene (BaP) is the most studied. PAH's are a major potential health hazard for retorting and refining workers in the oil shale industry because of the carcinogenicity. The problems that might be encountered in oil shale refining are similar to those of conventional oil refineries, where liquid and gases are transported in airtight pipes under strict maintenance to detect and repair leaks.

Crude oil contains an enormous variety of potentially hazardous compounds. Even more are produced during refining. Work crews involved in inspection, repair, and maintenance are the most likely to be exposed to PAH's. Other hazardous substances found in crude oil include chlorine, sulfur, nitrogen, and heavy metals (vanadium, arsenic, nickel, and cobalt). Toxic contaminants evolved during the refining process include hydrogen sulfide, hydrogen chloride, hydrochloric acid, sulfur dioxide, sulfuric acid, methane, ethane, methanol, nitric acid, nitrogen oxides, mercaptans, carbon monoxide, and benzene.

Two Estonian studies have shown an association between oil shale processing and cancer. A study of 2,003 Estonian oil shale workers with a total of 21,495 person-years exposure during the period between 1959 and 1975 found a significant excess of skin cancer (five-fold for females and three-fold for males). An unusually high incidence of stomach and lung cancer was found among persons in the rural areas of Estonia where the oil shale industry is located. There is no information on the working conditions in Estonian oil shale operations, nor is data available on the ambient concentrations of shale-derived pollutants in the vicinity of the plants. It is, therefore, impossible to relate the Estonian experience to problems that might be encountered in the United States.

SOCIETAL HAZARDS

Air pollutants include particulates, gases, and trace-metal vapors. Particulates which contain absorbed PAH can be carcinogenic. The sulfur and nitrogen-containing emissions are respiratory irritants. Among the sulfur-containing pollutants, the effects of acid sulfates, sulfuric acid, and sulfur dioxide dissolved in aerosols are the best documented. All three are irritants and can make breathing difficult. In addition, some epidemiological evidence relates chronic bronchitis and respiratory diseases to sulfur dioxide and to particulate concentrations in the air. Nitrogen oxides can react with hydrocarbons in the atmosphere to produce ozone, photochemical smog, and acid rain. Airborne ammonia may cause headaches, sore throats, eye irritations, coughing, and nausea in humans.

Among the trace elements that may be emitted, mercury, lead, cadmium, arsenic, and selenium are considered to be potential air and water pollutants. Arsenic is a carcinogen, which when inhaled or ingested in large amounts may also cause peripheral vascular disease and neuropathy. Mercury is a special problem because its vapors can pollute the air and earth many miles from the plant site. It can also contaminate surface streams and ground water aquifers. It can enter the food chain through the actions of microorganisms and can also pose a risk of irreversible neurological damage to humans who eat fish that have been contaminated by mercury in streams.

Leachates from aboveground disposal areas and burned-out in situ retorts also pose potential problems. PAH's, salts, and metals may dissolve in surface streams and ground water and infiltrate public drinking water supplies. Water-soluble salts in spent shale contain as much as 40 percent of the total benzene-soluble organic matter. All of these materials can be dissolved in water and dispersed through soils. The exact nature of the threat posed by these materials to human health is unknown since, for example, PAH's are found throughout nature. However, the PAH content of spent shale leachates (up to 100 to 1,000 times higher than is found in normal ground or surface water) is a matter for concern. Fluoride, if released in excessive amounts in contaminated water, may cause fluorosis (reduced bone strength and debilitation) and mottled tooth enamel.

The severity of these hazards would depend on many factors. Many of the risks could be very small if they are anticipated and if appropriate control strategies are designed and followed. If caution is not employed, or if there are catastrophic failures in the control systems during or after plant operation, damage could be severe and long-lasting.

SUMMARY OF HAZARDS AND THEIR SEVERITY

The safety and health hazards that might be associated with oil shale mining, retorting, and refining are identified in Table 3-3, and are ranked according to their known potential to cause injury or death. As shown, mining has the highest potential for accidents, due to risks from rockfalls, explosions, moving equipment, and general working conditions. There were two fatalities during the mining of over 2 million tons of shale and the production of over 500,000 bbl of shale oil. The accident rate has been one-fifth that for all mining and much lower than that for coal mining. However, this record was achieved in small-scale experimental mines that employed, for the most part, experienced hard-rock miners. Whether safety risks will increase or decrease as mining activities are expanded cannot be predicted. Risks might increase as the work force expands to include inexperienced miners and as large, rapidly moving, mining equipment is used. On the other hand, the large mines proposed for oil shale plants may reduce risks because of the additional room in which to maneuver machines.

TABLE 3-3

SUMMARY OF OCCUPATIONAL HAZARDS ASSOCIATED WITH OIL SHALE DEVELOPMENT

Occupational Risks	Potential Effect	Mining	Retorting	Refining
Accidents	Injury or death	H	M	L
Chemical Exposure	Cancer	L	M	M
Chemical Exposure	Dermatitis	L	M	M
Chemical Exposure	Irritant gases	M	M	M
Chemical Exposure	Poisoning	M	M	M
Dust	Dermatitis	L	M	L
Dust	Lung disease	H	M	L
Fires and explosions	Injury or death	L	M	M
Noise	Hearing loss or neurological damage	H	M	L

Source: Office of Technology Assessment 1980[a].

Note: H = higher level of risk; M = medium level of risk; L = lower level of risk.

Hazardous Wastes

The following was abstracted from Oil Shale 1982: A Technology and Policy Primer (November 1981).

Disposal of hazardous wastes has long been an important part of the controversy over oil shale development. The major concerns center on the placement and qualities of processed shale.

The Environmental Protection Agency (EPA) has not classified spent shale as a hazardous waste, although there has been some discussion of a special classification for oil shale and certain other high-volume mining and processing wastes. Any appreciable quantities of toxic, flammable, corrosive, or radioactive wastes that are produced by the industry would fall under the jurisdiction of the Resource Conservation and Recovery Act (RCRA). Those wastes would include coke and other concentrated hydrocarbons generated during upgrading and refining operations, sludges from wastewater treatment systems, and other wastes deemed hazardous under EPA's testing procedures.

Developers once planned to add the wastes to spent shale piles, but the implementation of new regulations under RCRA will force more elaborate approaches. Technologies for handling these materials have not been tested at a large scale, but there is little reason to believe that they would not work.

Reclamation

Of major concern in developing an oil shale industry is the reclamation of disturbed areas and spent shale disposal piles. The reclamation impacts would be the same regardless of alternative or level. The magnitude of impact would vary with the acreage disturbed (see Tables 3-1 and 3-2). The following are activities which would involve vegetation:

- Right-of-way construction would remove vegetation during the construction period for laying pipelines and installing power transmission lines and access roads.

- Building site construction would remove vegetation for the life of a project and until removal of buildings, parking lots, and other structures are completed.

- Underground mining of oil shale, coal, phosphate, and other minerals would remove a minimum acreage of vegetation from mine portals, ventilation shafts and other structures.

- Mine waste disposal and overburden pile would account for the largest acreage of disturbance for oil shale development and the longest period for revegetation. Spent shale would be deposited continuously for the life of the project and reclamation would, in most cases, be carried on concurrently with mining (BLM 1982g).

- Open pit mining would disturb the largest acreage of vegetation on a project site from stripping surface overburden and stockpiling of same.

Revegetation would require from 2 to 10 years to establish a ground cover of plants due to variable soils, temperature, elevation, and precipitation found throughout the oil shale region. The time required to restore vegetation to near pre-construction densities and dimensions would be from 2 to 10 years for grasses and forbs, 10 to 40 years for shrubs and brush, 20 to 100 years for trees, and as much as 300 years for certain commercial tree species to attain pre-construction dimensions.

Development would cause land disturbance that would require reclamation practices tailored to two different types of activity. These are: (1) disturbance caused by construction in rights-of-way, which would include pipelines for water, shale oil, natural gas, roads, railroads and transmission lines and (2) reclamation of the spent shale piles, open pit mines, and areas adjacent to building sites as well as the building sites following abandonment. Building sites include conveyors, retorts, shops and mine adits, and portals and shafts.

Reclamation practices have proven successful as reported by Tosco 1981; Institute for Land Rehabilitation 1979; Herbert and Berg 1974. Linear rights-of-way would require mechanical shaping of the disturbed areas as well as seeding adapted vegetation species to provide a plant cover at the earliest possible time following disturbance. Refer to Table 1-4 for a checklist of practices to be employed and expanded upon in the submission of the lessees' reclamation plan.

Reclamation practices developed by industry, universities, and government agencies would be employed, as applicable, to meet state and federal requirements. Reclamation would consist of first replacing soils in the sequence they were removed, contouring and installing erosion control structures, seeding or planting with appropriate adapted species of vegetation, applying mulch as appropriate, and finally following up with additional treatment, as necessary, to achieve the objectives as stated in the reclamation plan.

The degree of success in reclaiming soils and vegetation depends upon soil type and depth, climate, and topography. The basin areas that are characterized by shallow soils have a precipitation range of 4 to 8 inches annually and require periods of as much as 40 years to return a site to near pre-project conditions, although grasses, forbs and invader plants would establish a ground cover within 2 to 10 years. Mid-elevation areas where soils are deeper and precipitation ranges from 12 to 18 inches would recover with native grasses and forbs within 1 to 2 years and from 10 to 20 years for shrubs and brush species. The upper elevations with annual precipitation up to 30 inches would readily respond to reclamation measures with the expectation that soils would be stabilized within 1 to 2 years following disturbance. However, as much as 300 years would be required for trees to reach pre-construction dimensions.

Areas that do not presently support vegetative cover are not likely to be successfully revegetated following construction. However, in most cases, reclamation measures would improve drainage and soil structure to control soil erosion to pre-construction levels. Erosion could be significant after reclamation practices have been initiated should high intensity storms occur or adverse growing conditions persist to retard the revegetation process.

Success of reclamation and revegetation depends upon applying site-specific measures, the timing of the application, re-application where necessary, and maintaining structures or systems for managing grazing animals. Even with these practices and proven techniques, certain areas would require a more concentrated effort to achieve reclamation objectives.

Threatened or Endangered Species

The specific impacts of the proposed action or No-Action Alternative on threatened or endangered species of plants or animals cannot be determined at the program level of analysis. As described in Chapter 2, threatened or endangered plant and animal species exist within the oil shale region.

Development of any type, with its associated population increase within the oil shale region, would pose a threat to the identified species. Direct impact and surface disturbance would not be as likely a threat as increased use of the area from the population increase (see socioeconomic analysis). Section 7, Consultation Procedures, under the Endangered Species Act would require a survey prior to ground disturbance for all federally approved projects. If a species were to be affected, measures would be developed for protection or mitigation of that species.

Use of the oil shale region from the population increase associated with the proposed action and No-Action Alternative would place increased stress on the habitat of both plant and animal endangered species. This impact is difficult to predict and even more difficult to mitigate.

The procedures built into the proposed action would serve to identify and mitigate potential threatened or endangered species impacts. Additional site-specific analyses required under the proposed action program would identify potential specific impacts and develop (specific) mitigation measures.

Cultural Resources

The type of impact on cultural resources would not vary between the proposed action and No-Action Alternative. The magnitude of impact would vary according to the amount of surface disturbance and population increase. An estimate of the number of sites that could be affected by each alternative is provided under the impact analysis for each alternative and the proposed action. This section provides on overview of the type of impacts that could be expected and the causes of the impacts.

The magnitude of impact on cultural resources cannot be absolutely determined until inventories are conducted. Inventory would be required prior to authorization of surface-disturbing activities. As sites are identified, they will be evaluated for significance and possible inclusion on the National Register of Historic Places in compliance with regulations set forth in 36 CFR 800, E.O. 11593 and other historic preservation legislation. Appropriate mitigation procedures would also be developed at this time.

Development in the oil shale region would cause land modifications and population increases. Population increases in the area would result in increased off-road vehicle use and other activities, ultimately causing land modification, vandalism, and relic collecting; this could affect all known and unknown cultural resources within the region.

The impacts to cultural resources from these activities would be the destruction or alteration of the resources and the surrounding environment; displacement of artifacts; and introduction of visual, audible, and atmospheric elements out of character with the present environment. These impacts would cause a loss of scientific and cultural information and a loss of a portion of the resource base for future research.

The impacts from population increases are particularly significant, because the kinds of data lost to relic collecting are the major resources for dating and analyzing prehistory. Cultural resources are nonrenewable; consequently, the loss of any information could have a significant impact on efforts to reconstruct the prehistory and history of the study area. The types of sites and their significance are described in Chapter 2.

Paleontology

During the construction phase, earth-disturbing activities could damage or destroy both vertebrate and invertebrate fossils, whose quality, quantity, and significance have been discussed in Chapter 2. The direct access by construction/mining personnel and visitors to the fossil resources could lead to fossils being vandalized or illegally removed. Monitoring to control possible theft or vandalism would be difficult.

Surface-disturbing activities could also cause an additional erosion rate which would increase the rate of weathering damage to the fossils.

Some fossils which would otherwise have gone unnoticed, could be unearthed and undamaged during surface-disturbing activities. Salvaging these fossils would increase our knowledge and understanding of them and their environment. However, unmonitored collecting of fossils by the nonscientific community over time would result in a significant loss of research and exhibit material.

Net Energy Analysis

Following is a discussion of the net energy value costs of deriving petroleum products from oil shale.

GENERAL IMPACTS-NET ENERGY ANALYSIS

Overall energy efficiency is defined as "the net energy output divided by the net energy input times 100." Net energy outputs of any project are basically the Btu's contained in the product and by-products. Net energy inputs are much more complex, but they can be divided into sections, each of which can be dealt with separately and combined in various fashions as needed. The major sections of energy inputs for oil shale development are:

- Mining the shale or otherwise extracting it from the ground;
- Transporting the shale;
- Processing the shale;
- Transporting the shale oil, by-products, and waste products;
- Indirect energy including the energy needed to produce the fuels and equipment to do the job;
- Infrastructure energy including the energy used by employees, their families, and secondary industries (including social services).

Looking at the energy efficiency of oil shale development from these parameters still does not give the overall energy picture. It is possible to generate, on site, all the energy needed for mine and plant operations for a given project. However, in most cases, fuels will be imported and used in the mining/upgrading process. The amounts of two of the critical energy sources needed for various-sized projects (electricity and diesel) are shown in Table 3-4.

A typical project consisting of an underground mine, aboveground retorting, on-site upgrading, a product pipeline, and final refining is about 50 percent efficient, based on the energy in the ore removed from the ground.

A typical breakdown for the above-described example would be:

	Btu's
Net Energy Output	100
Net Energy Inputs	
Energy in Shale	155
Other Fuels Used	3
Indirect Energy	17
Infrastructure	25
Total Input	200
Percent Efficiency	50 percent

TABLE 3-4

ENERGY REQUIREMENTS AT THE MINE OF VARIOUS SHALE OIL PRODUCTION LEVELS

Production (bpd)	Electricity (Mw)	Diesel Fuel (bpy)
25,000	115	25,000
40,000	185	40,000
80,000	365	80,000
140,000	645	140,000

Source: Energy Analysis Handbook for Preparation of Oil Shale Environmental Impact Statement (Colorado School of Mines Research Institute 1982).

The final project efficiency will vary from site to site; some of the factors affecting this are:

- the amount of oil in a ton of oil shale;
- the depth of the mining zone or energy to move the ore to the plant;
- the distance that water and other fuels have to be transported to the site;
- the distance that the shale oil has to be transported to the refinery.

Considering the total in-place energy including the ore not mined, the overall efficiency from a project using a strip mine is about 42 percent and a project with a room-and-pillar mine would be about 30 percent efficient. The energy efficiencies of shale oil production and other energy sources are shown on Table 3-5.

Federal Land Management

At the program level of analysis, it is impossible to accurately predict impacts which could occur on land administered by any particular land managing agency. Future impact analysis of specific lease proposals would make these types of impact predictions. However, it can be stated that the direct impacts analyzed in this EIS that could occur from implementing the proposed action would occur on land administered by the Bureau of Land Management (BLM)--any oil shale leases that may be issued would be on BLM-administered land. Forest Service areas could also receive direct impacts from rights-of-way development. The National Park Service (NPS) would be affected by increased visitation as a result of increased population levels.

The impacts discussed in this EIS would affect the federal land management of the oil shale region. This section attempts to briefly summarize these impacts and discuss them in relationship to their impact on the land-managing agencies.

Approximately 80 percent of the land in the oil shale region is managed by BLM, the Forest Service, and NPS. These federal lands have been a primary source for dispersed and developed recreation facilities, grazing, timber, and mineral resources.

The Federal Land Policy and Management Act of 1976 (FLPMA) requires that these federal agencies must manage federal lands on the basis of multiple use and sustained yield, unless otherwise specified by law. The Forest Service is also required to ascribe to management policies of the Multiple Use-Sustained Yield Act (1960), National Forest Management Act of 1976, the Forest and Rangeland Renewable Resource Planning Act of 1974, and other appropriate acts.

Documents such as Development Impact on National Forests of Western Colorado and Energy Development Impacts on Rio Blanco and Rifle Districts indicate that, even at a pre-leasing level, federal lands in the Colorado area are currently affected by increased use of dispersed and developed recreation

TABLE 3-5

COMPARISON OF EFFICIENCIES OF ENERGY PRODUCTION FROM OIL SHALE AND OTHER ENERGY SOURCES

Energy Source	Percent Efficiency
Oil from tar sand strip mines	44
Shale oil from strip mine	42
Shale oil from underground mine	30

Source: Energy Analysis Handbook for Preparation of Oil Shale Environmental Impact Statement (Colorado School of Mines Research Institute 1982).

facilities. This trend is projected to continue because of the anticipated development of mineral resources and the westward movement of people toward the area.

In the event that federal oil shale leasing would occur, the major impacts on the federal lands would include developing nonrenewable energy resources on BLM lands, an increased demand on all federal lands for dispersed and developed recreation, a decrease in BLM lands available for grazing, and a subsequent higher demand for grazing on Forest Service land. These impacts would, in turn, increase the managerial responsibilities of each federal agency. In order to accommodate shifting and increased land use demands, each agency would also need to modify other programs or its organizational structure.

The extent of the impact on federal lands would be largely dependent upon the capacity of the BLM, Forest Service, and the NPS to implement intensive management and monitoring programs to maintain wilderness, recreation, grazing, and mineral resource values at a sustained yield and also to provide the necessary access roads, rights-of-way, and road maintenance for an organized, safe development of resources.

Unless appropriate changes were made, the federal land management agencies would not have the capacity to meet all of the previously listed responsibilities, which could result in an inability to mitigate the impacts of intense multiple use on federal lands. Decisions would need to be made with trade-offs and would probably be dictated by priority funding programs through the normal budgeting process of Congress.

NO-ACTION ALTERNATIVE

Low Level

AIR QUALITY

The air quality impacts in this EIS are summarized from the Air Quality Technical Report for the Federal Oil Shale Management Program, (Dietrich, et al. 1983), which should be referred to for additional detailed air quality analysis methodologies and results. This report may be obtained from Jack Edwards, Project Leader, BLM, Division of EIS Services, 555 Zang Street, First Floor East, Denver, Colorado, 80228; phone 303-234-6737. Appendix 2 provides a short summary of the methodologies and assumptions used to predict air quality impacts in this EIS.

Impacts to air quality were estimated using the Topographic Air Pollution Analysis System (TAPAS), a system composed of several air quality-related computer models (Childs and Marlatt 1981). The two primary TAPAS models used were WINDS and CITPUFF. The WINDS model simulates the wind flow in complex terrain based on topography, surface roughness, and meteorological boundary conditions. The CITPUFF model is an air pollution transport and dispersion model that uses the derived wind field, source emission data, topography, and meteorological boundary conditions to estimate ground-level pollutant concentrations downwind of individual or multiple sources. All figures depicting pollutant concentration levels were generated using these models.

The results of the air quality analysis must be evaluated with an understanding of the general limitations of air quality modeling in complex terrain - uncertainities of an order of magnitude (10^1) can be expected. The results are presented showing this range of accuracy, with the higher number representing the worst-case conservative (highest) estimate and the lower number, approximately an order of magnitude less. The potential for Prevention of Significant Deteoriation (PSD) Class I and Class II increment consumption is described throughout this EIS as high, moderate, or low, depending on the relationship between the predicted pollutant concentration range and the corresponding standard. The following convention was used: high potential, if the range was completely above the increment; moderate potential, if the range was "centered" around the increment; and low potential, if the upper end of the range was somewhat above the increment. Ranges completely below the increment are considered as no-potential and are not discussed.

Air quality modeling results indicate that no National Ambient Air Quality Standards (NAAQS) are violated under this scenario. No significant impacts are predicted to occur in PSD Class II areas except in the vicinity of the Buckskin Hills, Big Duck Creek, and Big Mountain areas (see Table 3-6). There is moderate potential for consumption of the PSD Class II TSP 24-hour increment in 1990 and 2000 for Buckskin Hills, and, in 2000, for Big Duck Creek and Big Mountain.

Modeling results show a moderate potential for consumption of the Colorado Category I SO_2 24-hour increment and low potential for consumption of the PSD Class II TSP 24-hour increment for 1990 and 2000 within Dinosaur National Monument. There is low potential that the PSD Class I SO_2 24-hour increment will be consumed within the Flat Tops Wilderness for 2000. Results (from Table 3-6) indicate that PSD Class I SO_2 24-hour increments are potentially exceeded within Mount Zirkel Wilderness, but it should be noted that this would not preclude leasing developments as the results are largely due to a "non-increment consuming" power plant, for which PSD increment considerations do not apply.

SOCIOECONOMICS

Table 3-7 presents the population and employment projections for the oil shale region and states for the No-Action Alternative, low level. For the region, population is expected to increase 3.6 percent annually from 1980 to 1990, and 3.2 percent annually from 1990 to 2000. A total population of 334,819 is predicted for the region by 1990 and 440,313 by 2000. In the 1980 to 1990 periods, as well as the 1990 to 2000, Utah would experience the highest annual growth rate, or 4.6 percent.

TABLE 3-6

RANGE OF 24-HOUR MODELED POLLUTANT CONCENTRATIONS (ug/m^3)
No-Action Alternative, Low Level

	1990 Low			2000 Low		
	TSP	SO_2	NO_X	TSP	SO_2	NO_X
Clean Air Act Requirements						
PSD Class I/Colorado Category I 24-hr Increment	10A	5	B	10A	5	B
PSD Class II 24-hr Increment	37	91	B	37	91	B
Sensitive Areas						
Class I Areas						
Flat Tops Wilderness (Colorado)	0-2	0-2	1-10	1-6	1-9	4-40
Mt. Zirkel Wilderness (Colorado)	0-2	1-13	1-14	0-2	1-13	2-15
Colorado Category I Areas						
Dinosaur National Monument (Colorado/Utah)	4-41	2-17	2-15	4-41	2-17	2-15
Class II Areas*						
1. Buckskin Hills (Utah)	13-131	0-5	0-5	13-131	0-5	0-5
2. Baxter Pass (Colorado)	0-4	0-4	3-29	1-6	2-25	4-36
3. Cottonwood Creek (Colorado)	1-8	0-1	3-34	3-29	0-5	12-116
4. Wolf Creek (Colorado)	1-9	2-23	7-66	2-16	3-28	11-112
5. Big Duck Creek (Colorado)	0	0	0-1	10-101	0-5	7-67
6. Big Mountain (Colorado)	1-14	1-6	4-36	7-68	3-27	16-164
7. East Miller Creek (Colorado)	1-6	0-5	3-31	1-13	1-13	7-67
8. Fontenelle Reservoir (Wyoming)	0	0	0	0	0	0
9. Jack Morrow Creek (Wyoming)	1-12	1-6	1-6	1-12	1-6	1-6
10. Whiskey Peak (Wyoming)	0-1	1-9	2-15	0-1	1-9	2-15

*See Table A-2-4 for detailed locations of Class II Areas

A - Total suspended particulate increments are not included in Colorado Category I standards.

B - There is no Prevention of Significant Deterioration (PSD) increment for nitrogen oxides, but concentrations of these pollutants can affect visibility and acidic deposition.

TABLE 3-7

PROJECTED POPULATION AND EMPLOYMENT LEVELS
No-Action Alternative, Low Level

	1980		1990		2000	
	Population	Employment	Population	Employment	Population	Employment
Colorado	110,299	53,708	145,582	67,834	176,785	85,727
Utah	63,501	25,131	92,473	36,665	134,961	58,723
Wyoming	71,469	36,875	96,764	50,037	128,567	65,765
TOTAL FOR REGION	245,275	115,714	334,819	154,536	440,313	210,215

Source: Wyoming data from preliminary Mountain West Research study--unpublised; Colorado data from Planning and Assessment System (PAS)--unpublished; Utah figures derived from Utah State Planning Coordinator's Office (1982).

Employment is predicted to grow by 4.9 percent per year from 1980 to 1990 for the oil shale region, which decreases to 3.6 percent for the 1990 to 2000 period. Total employment would reach 210,215 by 2000 for the oil shale region, a 102 percent increase over 1980. Colorado employment would be the fastest growing (6.3 percent) from 1980 to 1990. Utah would experience the fastest employment growth (6 percent) from 1990 to 2000.

Effects from the population and employment increases by 1990 would generally be insignificant. Effects from the growth by 2000 would be substantial in western Colorado. Increased employment would have a beneficial effect on local and regional economies, while considerable pressure would be exerted on local government to provide services and facilities to accommodate additional people.

QUALITY OF LIFE

The changes in quality of life are a direct result of the increase in population that is predicted to occur in the oil shale region (Table 3-7). The type of changes for each time period (1980 to 1990, 1990 to 2000) are the same; only the magnitude varies because of the continual increase in population. The impact on quality of life by the 2000 analysis point would also be directly related to the measures taken during the 1980 to 1990 period to mitigate the impact of the population expansion.

The projected 1990 population growth for Colorado would have moderate implications with regard to the social environment of the area. According to sociological literature on rapid growth, the pace of life in the affected communities (Rangely, DeBeque, Glenwood Springs, Meeker, Rifle, Parachute, and Grand Junction) would be further hastened, with more segmented interpersonal relations. Due simply to increased population levels, the communities, already undergoing diversification, would have higher levels of crime, family instability, drug and alcohol abuse, and a general sense of insecurity (women and the elderly would be particularly affected). Providing education, law enforcement, and social services along with housing would be a problem in some cases.

The population increase in Colorado by 2000 would result largely in extensions of the 1990 changes, with continuation of community segmentation, diversification, and impersonalization. Numbers, if not rates, of crimes, family dissolutions, and alcohol and drug abuse incidents would increase in general proportion to exceeding population changes by 2000. Housing supply would not likely be expanded at the pace of demand. Funding and provision of services by the community would continue to be difficult.

Uintah and Duchesne counties, Utah, would be most affected by population growth by 1990. During the 1980 to 1990 period, the population increase would cause moderate facility provision and service delivery problems, particularly in the Vernal and Roosevelt areas. However, due to past experience with energy-related growth and the mobilization of community resources to respond to this growth, the addition of the predicted projects for this time period and level should not cause problems of unsolvable magnitude in housing, residents' adaptation, and community segmentation. In short, the level of growth would be manageable at the local level and would be most pronounced during the construction period.

The 2000 community changes in Utah caused by the increase in population would involve substantial continuations of effects that initially appeared in the 1980 to 1990 period. Segmentation, diversification, and reduction in the sense of security among residents would continue, be more pronounced, and would be more visible by 2000. Delivery of services such as health care, law enforcement, education, and social services, along with public facility provisions, would be stressed. Disruptive behaviors such as crime, alcohol and drug abuse, and family conflicts would increase in proportion to or in excess of population growth rates. Housing supply would be short and costs high. While community experience in growth management would be valuable in dealing with these problems, the pace of growth would preclude effective response to many of them in the affected communities.

Sweetwater, Lincoln, and Uinta counties, Wyoming, would be moderately affected by 1990. These effects, based on experience with growth, would be similar to those described above for Utah. Wyoming would be expected to receive the same type of impact by 2000 as Utah, except to a lesser degree because of a lower population growth.

SURFACE WATER RESOURCES

The impacts on surface water resources were predicted through the use of the Bureau of Reclamation Colorado River Simulation System (CRSS). For an explanation of how the model was used for this EIS, refer to Appendix 2, which also contains detailed data used in the model, as well as the results. The reductions in flow and salinity changes for the various rivers are also shown. The data presented in this chapter of the EIS is a summary of these results.

By 1990, water use would increase approximately 50,000 ac-ft beyond present (1982) water use levels, as measured on the Colorado River at the inflow to Lake Powell. The largest increases in water use (depletions) would be on the White and Green rivers. Actual values would be 30,000 ac-ft, an 8 percent increase in depletion on the lower Green River (from Fontenelle Reservoir).

Collectively, these depletions represent a 1 percent or less reduction in flow in the Green River and in the Colorado River at the inflow to Lake Powell. The depletion from the White River would result in a 10 percent reduction in flow.

Due to these reductions in flow, salinity levels would increase over projected baseline conditions by 6 mg/l in the White River and by 8 mg/l in the Green River. Collectively, these increases in salinity would represent a 3 mg/l increase at Imperial Dam on the Colorado River.

In 2000, water use would have increased by approximately 128,000 ac-ft beyond present (1982) water-use levels as measured on the Colorado River at the inflow to Lake Powell. Increases in depletions would be from three rivers: 80,000 ac-ft from the White, 26,000 ac-ft from the Green, and 22,000 ac-ft from the Colorado. Collectively, these depletions represent a 1 percent or less decrease in flow on the Green and Colorado rivers and at the inflow to Lake Powell. The depletion from the White River would result in a 23 percent reduction in flow.

Due to these reductions in flow, salinity levels would change over projected baseline conditions by 10 mg/l on the White River and 11 mg/l on the Green River. Collectively, these increases in salinity represent an 11 mg/l increase at the inflow to Lake Powell and a 3 mg/l increase at Imperial Dam.

VEGETATION, SOILS, AND AGRICULTURE

Predicting impacts to vegetation, soils, and agriculture is difficult since the location of the areas to be disturbed or removed from production is not precisely known. Also, the data associated with the projects used in developing the various levels for the proposed action and the No-Action Alternative did not allow a determination of the ratio of acres reclaimed to amount disturbed. Therefore, the only data that could be used for impact analysis was an estimate of the amount that would be disturbed by each analysis point (Tables 3-1 and 3-2). A certain amount of the acreage disturbed would be reclaimed. The reclamation impacts and problems are presented in the general impact section of this chapter.

An estimate of the amount of crop and pasture land that could be removed by population increases is possible, 0.22 acres per capita (ARS 1971). These estimates are presented in the analysis of each level for the proposed action and the No-Action Alternative.

By 1990, activities in the oil shale region would result in disturbing vegetation on 112,600 acres. Both temporary and permanent vegetation losses would result in: (1) reduction of food production in the form of forage for wildlife and domestic livestock and (2) reduced ground cover as an agent in holding soil in place for erosion control and for watershed stability. The amount disturbed would increase to 139,000 by 2000, resulting in the same type of impacts as for 1990.

Secondary impacts from additional people using the land for recreation purposes would result from increased off-road vehicle use. Increased potential for wildfires would exist. Another factor would be utilizing wood for alternate heating fuel as a result of the projected population increase (Table 3-7).

Accelerated wind and water erosion would occur on areas disturbed from construction until reclamation practices would be completed (see General Impact Section). The impact of erosion upon soils from wind and water due to loss of natural cover is primarily a function of the amount of soil disturbed and the pattern of precipitation to cause runoff. The acreage of soil disturbance would be the same as identified for vegetation.

A population increase of 89,560 (Table 3-7) is predicted by 1990; this would result in the removal of 19,703 acres of crop and pasture land from production. This represents 2.7 percent of the agriculture base (729,741 acres) in the oil shale region. As a result of continued population growth, the acreage loss by 2000 would expand to 42,912 acres and 5.9 percent of the agricultural base. These conversions would be considered to be permanent since it would occur as a result of the expansion of the communities within the oil shale region.

Livestock grazing would be affected by the loss of pasture and forage on lands disturbed or converted to residential use. Loss of animal units months (AUM's) or livestock-carrying would occur, but cannot be quantified without knowing the location of disturbance due to the extremely variable forage types and landforms that determine livestock-carrying capacity.

The reduction in agricultural land in 1990 would not be considered significant on a regional level as the reduced acreage would be dispersed throughout the oil shale region, although certain individual livestock operations could be affected. Loss of agricultural land by 2000 (in the 5 to 10 percent range) would be considered significant due to the shortage of agricultural land in the oil shale region.

WILDLIFE

Wildlife impacts would result from habitat disturbance, removal of habitat, and increased use pressure from the expanding population. The direct habitat impacts would be of less concern than the impacts caused by population increases (Table 3-7). Predicting impacts on wildlife is difficult since the location of the disturbance is not precisely known. A straight line projection was used to estimate the impact of population growth.

For purposes of the wildlife impact sections, the impacts are calculated to occur in Moffat, Rio Blanco, Garfield, and Mesa counties in Colorado; in Carbon, Duchesne, Grand, and Uintah counties in Utah; and in Lincoln, Sublette, Sweetwater, and Uinta counties in Wyoming.

Total acres of habitat disturbed by 1990 would be 112,600, and 139,600 by 2000. Some portion of the 19,703 acres of pasture and cropland removal by 1990 and 42,912 acres by 2000 (see agriculture section, No-Action Alternative, low level) would also be considered wildlife habitat. The disturbance and loss by 1990 represents less than 1 percent of the total wildlife habitat available in the oil shale region, which increases to approximately 1.5 percent by 2000. It is also assumed that, at a minimum, these percents would also represent the loss of wildlife-carrying capacity. However, wildlife-carrying capacity might be reduced to a much greater degree depending upon the specific location of the disturbance and loss.

Table 3-8 presents the population increases and predicted increased pressure on wildife; the impacts would be the same in 1990 and 2000, but increased in magnitude by 2000.

TABLE 3-8

WILDLIFE IMPACTS
No-Action Alternative Low Level

State	Population Increase[1] 1990	Population Increase[1] 2000	Increased Pressure on Wildlife (Percent)[2] 1990	Increased Pressure on Wildlife (Percent)[2] 2000
Colorado	35,283	66,486	32	60
Utah	28,966	71,454	46	113
Wyoming	25,295	57,098	35	80

[1] Over 1980 baseline (see Tables 3-7 and 3-15 for sources).

[2] Represents increase in consumptive and nonconsumptive use and big game/auto accidents.

Increases in consumptive use of wildlife (i.e., hunting, fishing, and trapping) would force the wildlife management agencies of each of the three states to greatly alter its game and fish management strategies by 2000. Present-day game management strategies are generally based on orderly expansion of human populations and are usually placed in strategic plans set in 5-year periods. A large industry (such as oil shale) moving into wildlife areas and creating a "boomtown" situation adds people and other factors that were generally not anticipated in current strategic plans (Colorado Division of Wildlife 1977; Wyoming Game and Fish Department 1978). Because of unanticipated problems caused by energy developments, wildlife priorities change, direction for operational plans change, and budget planning has to be modified. Some management techniques that might have to be changed are: (1) lengths of hunting seasons would have to be shortened, (2) bag limits would have to be reduced, and (3) numbers of persons participating during certain seasons would have to be restricted. More restrictive hunting seasons could lead to an increase in illegal killing (poaching), which is expected to increase about 36 percent annually. Wanton killing would increase at an estimated 36 percent annually over present 1982 levels. As shown on Table 3-8, increased big game/automobile accidents are expected to occur; all of these impacts could lead to reduced populations of animals.

The reduction in river flows (see surface water resources, No-Action Alternative, low level) could affect the fishery habitat. Increased fishery pressure would also affect the fishery resource of the oil shale region.

RECREATION RESOURCES

By 1990, the increasing population (Table 3-7) would have several effects on dispersed outdoor recreation (see Chapter 2, Recreation Resources, for types occurring in the oil shale region). The anticipated increased population is expected to create additional numbers of people participating in dispersed outdoor recreation activities on lands with all types of ownerships. The quality of various types of recreation experiences would begin to decline in the oil shale region.

Conflicts would arise between recreationists and landowners due to increased numbers of people crossing or using private lands and landowners would begin to restrict access to and across their lands. The development of various projects would begin to reduce the amount of open land previously available for dispersed recreation opportunities, probably occurring predominantly in Utah and Colorado.

No destruction of any recreational developments due to project activities would likely occur. However, increased populations utilizing existing facilities in the oil shale region would create an additional workload and a need for additional monies for collecting garbage, rebuilding vandalized sites, and constructing new recreation sites, while existing facilities become overloaded.

Urban recreation facilities would become overcrowded due to expected increases in use. In Wyoming, the urban recreation resources are currently inadequate (BLM 1978). Demand for urban recreation, in the communities within the region where people associated with oil shale development would live, would exceed the current supply of facilities.

Trails, either existing or proposed for classification within the National Trails System, are not expected to be affected by 1990.

As population continues to increase, by 2000 (Table 3-7), this growth is anticipated to place much more demand on dispersed recreation opportunities. The quality of recreation experiences would diminish considerably from the present situation. Increased competition for favored locations and facilities and regional air quality deterioration would contribute to this decline. Landowner/recreationist conflicts would increase, which would result in more land posted against trespass. Continued development of various projects would further reduce the amount of land previously available and suitable for dispersed recreation opportunities.

The historic, scenic, and recreational trails on the National Trails System may begin to deteriorate and require greater maintenance due to heavier use. Rights-of-way for linear facilities to support facility development may cross certain trails.

The use and demand for urban recreation facilities would increase, resulting in overcrowded facilities and a general decline in user satisifaction.

WILDERNESS

Impact on wilderness areas has a direct relationship to population increase (Table 3-7). Use of wilderness areas would increase proportionately to population in the oil shale region. Impacts on wilderness values would result from increased use. Decreasing air quality would also affect wild erness values. The air quality-related impacts on wilderness are discussed in each of the air quality sections of this EIS.

The population increase would be expected to cause an increase in demand beyond 1982; by 1990, for primitive recreational experiences found within wilderness units in the Secondary Zone of Influence. This increase in demand from the local region would probably be absorbed with a slight shift toward the wilderness units that are currently less popular than other areas that would reach the threshold for sociological and physical-carrying capacities.

The areas which are currently the most popular are likely to continue to have that status. At an unknown point, a high user-density will probably cause persons with a low tolerance for seeing other people during a primitive recreational experience to shift their use to less popular areas.

The impacts by 2000 would be a continuation and worsening of the 1990 impacts. The 2000 increase in population would create a similar, but lesser, increase in the demand for primitive recreational experiences in wilderness units within the Secondary Zone of Influence. Agencies managing wilderness units would be expected to have increased workloads. To manage user demands, they may need to implement daily quotas and permit systems in many of the more popular wilderness units. The quality of the primitive recreational experience would be expected to diminish in some of these wilderness units, because of increased user contacts and general resource deterioration. This would cause user pressure to shift more to the previously less popular units, as people try to have as much isolation as possible.

VISUAL RESOURCES

Visual resources would be affected by vegetative disturbance caused by construction activities and placement of new facilities (transmission lines, buildings) on the landscape. Specific impacts and their significance cannot be determined until specific project locations are known.

By 1990, the economic growth and development within the oil shale region would create contrasts between the natural appearing landscape and changes in landform and vegetative patterns. Most of these changes would be caused by building transmission lines, highways, pipelines, and other forms of linear systems. Additionally, surface coal mines would create contrasts in landform modification and vegetative clearings. Subsurface mining, created by the oil shale industry, would create surface disturbance in the form of landform modification where spent shale piles would be created, vegetative clearings would occur, and numerous structures would be placed upon the landscape. Other projects would create similar impacts, but generally would not change the overall visual image of the region as viewed from the ground or from commercial aircraft. Additionally, most impacts would occur in VRM Class III and IV areas, except where linear systems would enter river bottoms or communities would be expanded. Approximately 112,600 acres would be disturbed and undergo visual impacts, of which, an undetermined number of acres would be termed as significantly, adversely affected. However, the visual impacts should generally remain insignificant at the regional level.

By 2000, the impacts on visual resources would be much more intense. The increase in impacts would occur as a result of cumulative effects since most site-specific influences would not be significant in themselves, but would extend far beyond the sight of the viewer and, thus, contribute toward regional effects. The general "sense" or visual image of the region would begin to change with increased development as the network of linear systems and mine development would begin to create manufactured patterns upon the natural landscape. Approximately an additional 27,000 (139,600 total) disturbed acres would undergo visual impacts, of which, an undetermined number of acres disturbed would be considered significantly, adversely affected. Most changes would occur in VRM Class III and IV areas, with Class II areas being affected primarily by linear system impacts.

CULTURAL RESOURCES

By 1990, approximately 112,600 acres would be disturbed. Assuming a regional site density of 1.0 to 5.4 sites per square mile (Weber 1977), 176 to 950 sites may be affected by surface disturbance, increasing to a total of 218 to

1,178 sites by 2000. The actual type of sites affected and their significance cannot be determined at this time. They could vary from minor, insignificant, sites to major sites which would be of National Register significance. Chapter 2 provides a brief overview of the types of sites which may be found.

MINERAL RESOURCES

The approximate production of shale oil in 1990 would be 83,000 barrels per day (bpd). Over 30 years, this would represent 0.81 billion barrels of shale oil and 0.5 percent of the recoverable resources in the oil shale region.

The approximate production of shale oil in 2000 would be 367,000 bpd; over 30 years, this would represent 3.6 billion barrels of shale oil or 0.21 percent of the recoverable resources in the oil shale region.

TRANSPORTATION NETWORKS

By 1990, an estimated 947,600 daily trips would be generated (assuming 7.5 daily trips per household and an average household size of 2.65), constituting an increase of 37 percent over the 1980 number of daily trips. No specific estimates can be made of additional truck traffic, but truck traffic would increase, the actual extent of which would depend upon whether by-products (such as nahcolite and dawsonite) are marketed and whether various products are shipped by pipeline. Truck and rail traffic could increase if by-products are marketed. Rail traffic could also increase as more facilities are constructed, resulting in movement of material and equipment to key railheads.

These increases would affect 1,100 miles of roadway by further stressing already deficient roadways. The impacts would be the greatest in Colorado where the highest percentage of deficient roadways exist.

These impacts cannot be quantified due to lack of specific information (e.g., location of projects, highways to be used, load numbers); however, the types of impacts would involve further structural deterioration of roads, increased traffic and congestion, and the possible increased risk of accidents.

By 2000, an estimated 1.25 million daily trips would be generated, which would be 68 percent over the 1980 level. Truck and rail traffic would also increase, but the extent would depend upon marketing by-products and shipping products. These increases would extend over the same mileage of roadways as for 1990. The impacts, however, would be more severe than those identified for 1990 due to the increased number of trips (298,569).

High Level

The impacts for 1990 would generally be the same as those described for 2000 under the low level (see Figure 3-1). Some minor, unmeasurable (with current techniques) differences may exist as a result of some changes in the non-oil shale projects category. However, current data does not allow for these differences to be determined. Therefore, the following impact discussions deal only with 2000.

AIR QUALITY

A brief summary of the methodologies and assumptions used to predict air quality impacts is given in Appendix 2.

Air quality modeling results indicate that no National Ambient Air Quality Standards (NAAQS) are violated under this scenario. No significant impacts occur in PSD Class II areas except in the vicinity of the Buckskin Hills, Big Duck Creek, and Big Mountain areas, (see Table 3-9) which show moderate potential for consumption of the PSD Class II TSP 24-hour increment in 2000. Low potential for consumption of the PSD Class II TSP 24-hour increment exists for the area around Cottonwood Creek for 2000. There is moderate potential for consumption of the Colorado Category I SO_2 24-hour increment and low potential for consumption of the PSD Class II TSP 24-hour increment in Dinosaur National Monument for 2000. Modeling results indicate moderate potential for consumption of the PSD Class I TSP and SO_2 24-hour increments for 2000 within Flat Tops Wilderness. Results (from Table 3-9) indicate that PSD Class I SO_2 24-hour increments are potentially exceeded within Mount Zirkel Wilderness, but it should be noted that this would not preclude leasing developments as the results are largely due to a "non-increment consuming" power plant for which PSD increment considerations do not apply.

SOCIOECONOMICS

Table 3-10 contains the population and employment projections for the No-Action Alternative, high level, 2000. The population for the oil shale region is predicted to reach 489,759 by 2000, a 99.7 percent increase over the 1980 baseline. Most of the increased population (a 153 percent increase over 1980) and employment is expected in Utah. Colorado's population and employment would grow by 82 percent and 137 percent, respectively, over 1980; Utah's would grow by 153 and 16.8 percent over 1980. Wyoming's population and employment would grow by 80 and 78 percent over 1980's.

These increases would cause significant impacts, both positive and negative, on communities and counties. Increased jobs and income would have a beneficial effect throughout the oil shale region, but these would be offset by the need to furnish needed community services and facilities to accommodate the increased population. Much of the community infrastructure would be needed prior to availability of monies from the enhanced tax base.

QUALITY OF LIFE

Population growth associated with the No-Action Alternative, high level, in Colorado during the 1980 to 2000 period would cause profound and extensive social changes in Garfield, Mesa, and, in particular, Rio Blanco, counties. Annual growth rates would be at a level that would make the provision of

TABLE 3-9

RANGE OF 24-HOUR MODELED POLLUTANT CONCENTRATIONS (ug/m^3)
No-Action Alternative, High Level

	2000 High		
	TSP	SO$_2$	NO$_X$
Clean Air Act Requirements			
PSD Class I/Colorado Category I 24-hr Increment	10A	5	B
PSD Class II 24-hr Increment	37	91	B
Sensitive Areas			
Class I Areas			
Flat Tops Wilderness (Colorado)	2-16	2-24	9-94
Mt. Zirkel Wilderness (Colorado)	0-2	1-13	2-15
Colorado Category I Areas			
Dinosaur National Monument (Colorado/Utah)	4-41	2-17	2-15
Class II Areas*			
1. Buckskin Hills (Utah)	13-131	0-5	0-5
2. Baxter Pass (Colorado)	1-8	6-55	5-46
3. Cottonwood Creek (Colorado)	6-59	1-11	23-231
4. Wolf Creek (Colorado)	3-34	5-49	22-216
5. Big Duck Creek (Colorado)	20-202	1-11	13-134
6. Big Mountain (Colorado)	17-167	8-79	40-400
7. East Miller Creek (Colorado)	3-30	3-29	13-129
8. Fontenelle Reservoir (Wyoming)	0	0	0
9. Jack Morrow Creek (Wyoming)	1-12	1-6	1-6
10. Whiskey Peak (Wyoming)	0-1	1-7	2-15

*See Table A-2-4 for detailed locations of Class II Areas

A - Total suspended particulate increments are not included in Colorado Category I standards.

B - There is no Prevention of Significant Deterioration (PSD) increment for nitrogen nitrogen oxides, but concentrations of these pollutants can affect visibility and acidic deposition.

TABLE 3-10

PROJECTED POPULATION AND EMPLOYMENT LEVELS
No-Action Alternative, High Level

	1980		2000	
	Population	Employment	Population	Employment
Colorado	110,299	53,708	200,768	98,762
Utah	63,507	25,131	160,424	68,073
Wyoming	71,469	36,875	128,567	65,765
Total for Region	245,275	115,714	489,759	232,600

Source: Wyoming data from preliminary Moutain West Research study-unpublished; Colorado data from Planning and Assessment System (PAS), unpublished; Utah figures derived from Utah State Planning Coordinator's Office (1982).

public services difficult. Housing would be in short supply and would be costly. Reports of crime, drug and alcohol abuse incidents, family disruptions, and similar behaviors would increase rapidly. Women and the elderly, in particular, would be less secure in communities with many newcomers, increased congestion, and decreased familiarity among residents.

The population growth would also have very significant Utah community social implications. Duchesne and Uintah counties, in particular, would face annual population growth levels that would lead to pronounced problems in housing, law enforcement, education, and community adaptation to change. Crime, family instability, alcohol and drug abuse, and similar sources of community disruption would increase at a rate equal to or exceeding the growth of population. Reduced sense of security, particularly among women and the elderly, would accompany this growth as Vernal, Roosevelt, and other communities would become more diverse, segmented, and impersonalized. This level of population growth would present serious growth management problems for officials in this area. The effects in Wyoming would be similar to those described above for Utah but on a slightly smaller level since population growth in Wyoming would not be as dramatic as in Utah.

SURFACE WATER RESOURCES

By 2000, water use (depletions) would increase by about 304,000 ac-ft over present water use levels as measured at the inflow to Lake Powell. Depletions would increase at five measuring points (see Figure A-2-1): Colorado River, 11 percent; White River, 46 percent; Green River (at mouth), 23 percent; Yampa River, 10 percent; and Green River (at Fontenelle Reservoir), 15 percent. Collectively, these depletions would represent a 3 percent reduction in flow on the Colorado River at Lake Powell (see Figure A-2-3). Other reductions in flow would be as follows: Green River (at mouth), 2 percent; White River (at mouth), 40 percent; and Duchesne River, 4 percent.

Due to these reductions in flow, salinity levels (see Figure A-2-4) would change over projected baseline conditions by 13 mg/l at the mouth of the White River and 19 mg/l at the mouth of the Green River. These two changes in salinity would result in a 14 mg/l increase in the Colorado River at the inflow to Lake Powell and a 7 mg/l increase at Imperial Dam.

VEGETATION, SOILS, AND AGRICULTURE

Vegetation would be disturbed on a total of 167,000 acres, which remains less than 1 percent of the total acreage of the region. Loss of vegetation that is less than 1 percent would be considered insignificant at the regional level of analysis but could be significant at the local level if that loss would affect other resources. This acreage would be spread over three states and, in all probability, would be widely spaced; therefore, the regional impact would not significantly remove vegetation in any one vegetation type.

The increased population (Table 3-10) is predicted to convert 53,790 acres of agricultural land to urban use by 2000, or 7.4 percent of the agricultural base. Livestock grazing losses cannot be determined at this time but would occur, to the greatest extent, on private and state land except for rights-of-way on federal lands. This loss of pasture and cropland would be significant since it exceeds USDA's 5 percent significance criteria. This 5 percent is based upon the potential of the number of ranch and farm units that could go out of business due to loss of pasture and grazing land.

WILDLIFE

Approximately 167,000 acres of wildlife habitat, less than 1 percent of the available vegetative habitat available in the oil shale region, is predicted to be disturbed. However, depending on location, the percent of habitat disturbed could be far greater. Projects located in critical wildlife areas may disturb more than 1 percent of the habitat. These potentially critical disturbances will be addressed in future land-use planning documents.

Table 3-11 presents the increased pressure impacts on wildlife resulting from population increases. Increases in consumptive use of wildlife (i.e., hunting, fishing, and trapping) would force the wildlife management agencies of each of the three states to greatly alter their game and fish management strategies by 2000 (see No-Action Alternative, low level, Wildlife). Changes in management techniques could lead to an increase in illegal killing (poaching) and wanton killing which could increase about 99 percent over the entire region.

Flows in the Yampa, White, Green, and Colorado rivers would be reduced (see No-Action Alternative, high level, Surface Water Resources). Based on information contained in the Biological Opinion for White River Dam Project (U.S. FWS 1982), any reduction in flows in the White River could adversely affect the existence of the Colorado squawfish; the same reasoning can be extrapolated to other rivers in the drainage system.

RECREATION RESOURCES

The regional population in the three-state area would increase 99 percent to 489,759 from the 1980 level of 245,259. Demand on and impact to dispersed recreation opportunities would increase substantially. The quality of recreation experiences would continue to diminish because of crowding, competition for facilities, and increased pressure on wildlife.

At an undefined point of declining quality, out-of-state tourists and recreationists, including hunters and fishermen, would probably stop traveling to this region and seek recreation opportunities elsewhere. This could alleviate some of the pressure on regional sites and facilities, but would cause secondary effects of regional development to be dispersed further, because people would travel to other regions not previously utilized.

Most private land would be posted against trespass, and access to open space would continue to become more difficult. Trails, either existing or proposed for classification on the National Trails System, may continue to receive heavier user pressure. The potential for direct impact from development would increase if development were to occur in the vicinity of the trails.

TABLE 3-11

WILDLIFE IMPACTS
No-Action Alternative, High Level, 2000

State	Population Increase[1]	Increase Pressure on Wildlife (percent)[2]
Colorado	90,469	82
Utah	96,917	153
Wyoming	57,098	90

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[1] Over 1980 baseline (see Tables 3-7 and 3-15 for sources).

[2] Represents increase in consumptive and nonconsumptive use and big game/auto accidents.

NO-ACTION ALTERNATIVE-HIGH LEVEL-WILDERNESS

WILDERNESS

A population growth of approximately 99 percent would increase demand for wilderness recreation experiences. Daily use quotas on many or most of the wilderness units in the area would probably be necessary and agency work loads would be greatly increased.

The quality of the primitive recreation experience in most of the wilderness units within the Secondary Zone of Influence would be expected to decline because of the potential for user conflicts and greatly increased user contacts. The use of previously less-popular wilderness areas would increase as more isolated wilderness units would likely be sought.

VISUAL RESOURCES

The types of impacts would be similar to those impacts occurring under the No-Action Alternative, low-level. By 2000, with 167,000 acres disturbed, the visual "sense" of the region would show signs of modification as significant adverse levels of visual contrast would become visible. An undetermined amount of impacts would most generally occur in VRM Class III and IV areas with some changes being caused by the introduction of linear systems in VRM Class II areas.

CULTURAL RESOURCES

Assuming a regional site density of 1.0 to 5.4 sites per square mile (Weber 1977), 261 to 1,409 sites may be effected by surface disturbance. As disturbed acreage increases, the probability for impacts on significant sites also increases.

MINERAL RESOURCES

The approximate production of shale oil at this analysis point would be 853,000 bpd. Over 30 years, this would represent 8.4 billion barrels of shale or 0.49 percent of the recoverable resources in the oil shale region.

TRANSPORTATION NETWORKS

An estimated 1.4 million daily trips would be generated in the oil shale region. Much of this increased traffic, including truck and rail, would be due to increase oil shale activity.

Impacts would occur over 1,100 miles of roadway, with the most severe impacts occurring in Colorado. The types of impacts would be similar to those discussed for the No-Action Alternative, low level, 1990, but would be more widespread.

PROPOSED ACTION

Projecting impacts which could result from adoption and implementation of proposed rulemaking such as the proposed action is necessarily a speculative endeavor. Regional and site-specific environmental analyses will be accomplished prior to approval of future land-use planning decisions, oil shale lease sales, and mine plans. At each successive stage of oil shale development, the proposals, as well as the environmental analyses and mitigation measures, become more specific.

In order to compare the environmental impacts of the proposed action (i.e., regulations) to the various baselines, hypothetical levels of oil shale development have been assumed. Only generic, not site-specific, impacts have been identified and are assessed to determine: (1) possible environmental constraints at two development levels and (2) areas of environmental concerns that should be addressed in the proposed regulations.

It is difficult to link a hypothetical future level of oil shale development with any variation of the proposed oil shale leasing program. The Secretary will be allowed discretion to choose leasing levels under any oil shale leasing program. If an oil shale leasing program is adopted, it should be tailored to avoid or mitigate the generic impacts identified in the following section.

For both the low- and high-level analyses for the proposed action, it is assumed that if new leases are issued under the regulations, they would not be in production by 1990. Therefore, the only impact analysis for the proposed action is conducted for the 2000 time point (see Figure 3-1). In addition, a two-level impact analysis was conducted. The predicted impact of the new federal leasing by itself is presented first, then the cumulative impact (the impact of the proposed action plus the baseline) is presented.

Low Level

AIR QUALITY

A brief summary of the methodologies and assumptions used to predict air quality impacts is given in Appendix 2.

Air quality modeling results indicate that no National Ambient Air Quality Standards (NAAQS) are violated under this scenario. The proposed action (leases only) and cumulative (all sources) modeling results are presented in Table 3-12. Figures 3-2 and 3-3 show the predicted cumulative 24-hour concentration isopleths for TSP and SO_2, respectively. The results indicate that the proposed action (leases only) is not likely to cause total consumption of any PSD Class I or II increments. The proposed action contributes to two of three cumulative concentrations which indicate a moderate potential for consumption of the PSD Class II TSP 24-hour increment in the vicinity of the Buckskin Hills, Big Duck Creek, and Big Mountain areas. There is no contribution by the proposed action to an area within Dinosaur National Monument that indicates a low potential for consumption of the PSD Class II TSP 24-hour increment and a moderate potential for

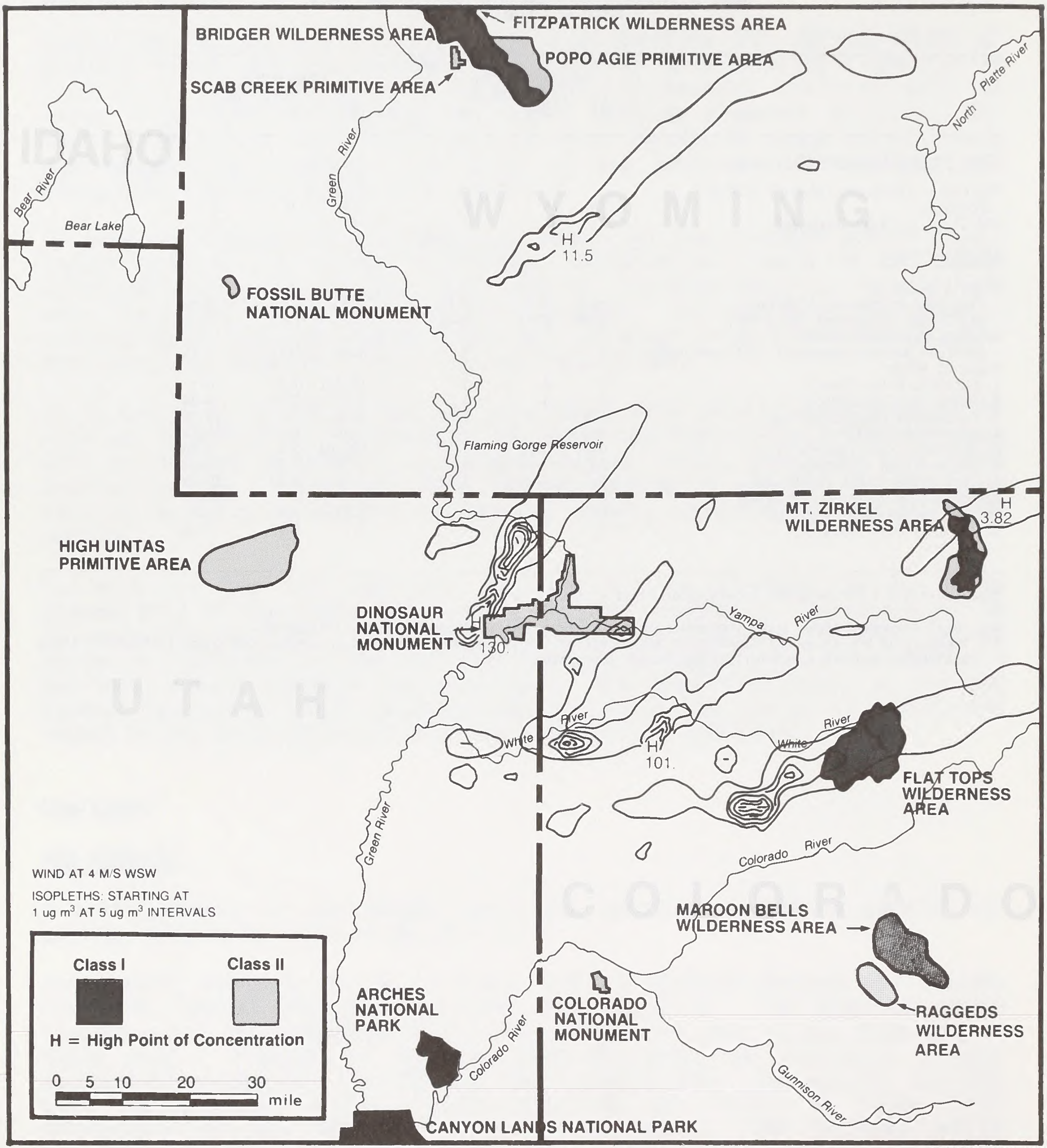
TABLE 3-12

RANGE OF 24-HOUR MODELED POLLUTANT CONCENTRATIONS (ug/m^3)
Proposed Action, Low Level

	2000 Low					
	Proposed Action (Leases Only)			Cumulative (All Sources)		
	TSP	SO_2	NO_X	TSP	SO_2	NO_X
Clean Air Act Requirements						
PSD Class I/Colorado Category I 24-hr Increment	10A	5	B	10A	5	B
PSD Class II 24-hr Increment	37	91	B	37	91	B
Sensitive Areas						
Class I Areas						
Flat Tops Wilderness (Colorado)	0-3	0-4	2-16	1-9	1-13	6-56
Mt. Zirkel Wilderness (Colorado)	0->1	0->1	0->1	0-2	1-13	1-15
Colorado Category I Areas						
Dinosaur National Monument (Colorado/Utah)	0	0	0	4-41	2-17	2-15
Class II Areas*						
1. Buckskin Hills (Utah)	0	0	0	13-131	0-5	0-5
2. Baxter Pass (Colorado)	0	0	0	1-6	2-25	4-36
3. Cottonwood Creek (Colorado)	1-6	0-2	3-29	4-35	1-7	14-145
4. Wolf Creek (Colorado)	0	0	0	2-16	3-28	11-112
5. Big Duck Creek (Colorado)	0->1	0->1	0-1	10-101	0-5	7-68
6. Big Mountain (Colorado)	0->1	0->1	0->1	7-68	3-28	16-164
7. East Miller Creek (Colorado)	1-7	1-8	3-32	2-20	2-20	10-99
8. Fontenelle Reservoir (Wyoming)	0	0	0	0	0	0
9. Jack Morrow Creek (Wyoming)	0	0	0	1-12	1-6	1-6
10. Whiskey Peak (Wyoming)	0	0	0	0-1	1-9	2-15

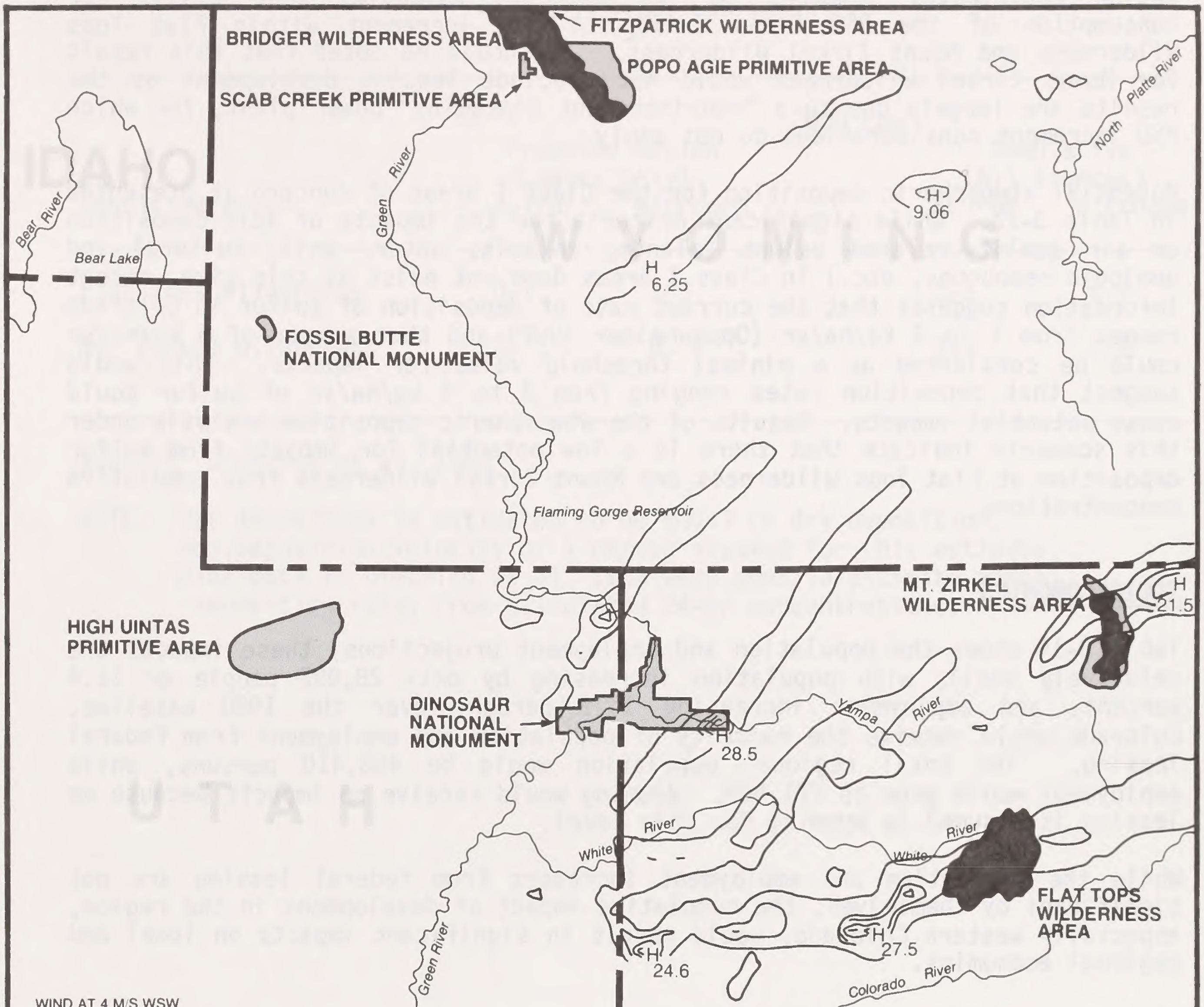
*See Table A-2-4 for detailed locations of Class II Areas

A - Total suspended particulate increments are not included in Colorado Category I standards.
B - There is no Prevention of Significant Deterioration (PSD) increment for nitrogen oxides, but concentrations of these pollutants can affect visibility and acidic deposition.


FITZPATRICK WILDERNESS AREA
BRIDGER WILDERNESS AREA
POPO AGIE PRIMITIVE AREA
SCAB CREEK PRIMITIVE AREA
IDAHO
WYOMING
North Platte River
Green River
Bear River
Bear Lake
H
11.5
FOSSIL BUTTE NATIONAL MONUMENT
Flaming Gorge Reservoir
HIGH UINTAS PRIMITIVE AREA
MT. ZIRKEL WILDERNESS AREA
H
3.82
DINOSAUR NATIONAL MONUMENT
H
130.
Yampa River
UTAH
White River
H
101.
White River
FLAT TOPS WILDERNESS AREA
Green River
Colorado River
COLORADO
WIND AT 4 M/S WSW
ISOPLETHS: STARTING AT 1 ug m3 AT 5 ug m3 INTERVALS
Class I
Class II
H = High Point of Concentration
0 5 10 20 30
mile
MAROON BELLS WILDERNESS AREA
ARCHES NATIONAL PARK
COLORADO NATIONAL MONUMENT
Colorado River
RAGGEDS WILDERNESS AREA
Gunnison River
CANYON LANDS NATIONAL PARK

SOURCE: DIETRICH ET. AL., 1983

FIGURE 3-2 CUMULATIVE 24-HR TSP GROUND LEVEL CONCENTRATIONS, PROPOSED ACTION, LOW LEVEL, 2000


FITZPATRICK WILDERNESS AREA
BRIDGER WILDERNESS AREA
POPO AGIE PRIMITIVE AREA
SCAB CREEK PRIMITIVE AREA
North Platte River
Green River
Bear River
Bear Lake
H 9.06
H 6.25
FOSSIL BUTTE NATIONAL MONUMENT
Flaming Gorge Reservoir
MT. ZIRKEL WILDERNESS AREA
H 21.5
HIGH UINTAS PRIMITIVE AREA
DINOSAUR NATIONAL MONUMENT
Yampa River
H 28.5
White River
White River
FLAT TOPS WILDERNESS AREA
H 27.5
H 24.6
Green River
Colorado River
WIND AT 4 M/S WSW
ISOPLETHS: STARTING AT 1 ug m3 AT 5 ug m3 INTERVALS
MAROON BELLS WILDERNESS AREA
Class I
Class II
H = High Point of Concentration
ARCHES NATIONAL PARK
COLORADO NATIONAL MONUMENT
RAGGEDS WILDERNESS AREA
Colorado River
Gunnison River
0 5 10 20 30 mile
CANYON LANDS NATIONAL PARK

SOURCE: DIETRICH ET. AL., 1983

FIGURE 3-3 CUMULATIVE 24-HR SO_2 GROUND LEVEL CONCENTRATIONS, PROPOSED ACTION, LOW LEVEL, 2000

consumption of the Colorado Category I SO_2 24-hour increment. The proposed action contributes somewhat to the moderate potential that exists for consumption of the PSD Class I SO_2 24-hour increment within Flat Tops Wilderness and Mount Zirkel Wilderness. It should be noted that this result for Mount Zirkel Wilderness would not preclude leasing development as the results are largely due to a "non-increment consuming" power plant, for which PSD increment considerations do not apply.

Potential atmospheric deposition for the Class I areas of concern is presented in Table 3-13. While significant criteria for the impacts of acid deposition on air quality-related values (plants, animals, water, soil, cultural and geologic resources, etc.) in Class I areas does not exist at this time, recent information suggests that the current rate of deposition of sulfur in Colorado ranges from 1 to 2 kg/ha/yr (Oppenheimer 1982) and that a rate of 5 kg/ha/yr could be considered as a minimal threshold value for impacts. This would suggest that deposition rates ranging from 3 to 4 kg/ha/yr of sulfur could cause potential impacts. Results of the atmospheric deposition analysis under this scenario indicate that there is a low potential for impacts from sulfur deposition at Flat Tops Wilderness and Mount Zirkel Wilderness from cumulative concentrations.

SOCIOECONOMICS

Table 3-14 shows the population and employment projections; these impacts are relatively small, with population increasing by only 28,097 people or 11.4 percent, and employment increasing 10.9 percent over the 1980 baseline. Colorado would receive the majority of population and employment from federal leasing. The total regional population would be 468,410 persons, while employment would grow to 221,505. Wyoming would receive no impacts because no leasing is assumed in Wyoming for this level.

While the population and employment increases from federal leasing are not significant by themselves, the cumulative impact of development in the region, especially western Colorado, would result in significant impacts on local and regional economics.

QUALITY OF LIFE

Federal leasing, production, and the attendant population growth levels in Rio Blanco, Garfield, and Mesa counties would result in significant local community social changes. Problems discussed previously (No-Action Alternative, low level), ranging from housing shortages, service provision shortfalls, and segmentation to increased numbers of incidents of crime, drug and alcohol abuse, and family disturbances would be more extensive and more visible to residents, further reducing, in particular, the sense of security of women and the elderly.

The Utah community changes that would be attributable to this level of federal leasing, relative to the changes that would be caused by implementation of the No-Action Alternative, are moderate. The differences would primarily be in

TABLE 3-13

POTENTIAL TOTAL ATMOSPHERIC DEPOSITION ON CLASS I AREAS (kg/ha/yr)

Proposed Action, Low Level

	2000 Low			
	Proposed Action (Leases Only)		Cumulative (All Sources)	
Sensitive Area	Sulfur	Nitrogen	Sulfur	Nitrogen
Flat Tops Wilderness	0-1	1-3	2-3	6-9
Mt. Zirkel Wilderness	0- 1	0- 1	2-3	1-2

Source: Dietrich et al. 1983

NOTE: Wet deposition is estimated to be equal to dry deposition. Dry deposition velocity of 1 cm/sec assumed for this estimate. Wind data in Dietrich et al. 1983 were used to estimate annual deposition rates from calculated 24-hr concentrations.

TABLE 3-14

PROJECTED POPULATION AND EMPLOYMENT LEVELS
Proposed Action, Low Level

State	1980		2000			
			Proposed Action		Cumulative	
	Population	Employment	Population	Employment	Population	Employment
Colorado[a]	110,299	53,708	21,762	8,568	198,547	94,295
Utah[b]	63,507	25,131	6,335	2,722	141,296	61,445
Wyoming[c]	71,469	36,875	0	0	128,567	65,765
Total for Oil Shale Region	245,275	115,714	28,097	11,290	468,410	221,505

[a] Calculated using the Planning and Assessment System (PAS) of the Colorado Department of Local Affairs.

[b] Figures devised by applying the following factors to assumed employment figures for possible new lease operations (Source of assumptions: Colorado Department of Highways, 1977):

1. 90 percent direct and indirect work force married, 10 percent single.
2. Average family size for married is 3.25.
3. Employment multiplier = 1.8.
4. Ten percent of employment increases filled locally or by a member of an in-migrant.
5. Thirty percent of secondary jobs filled by spouses.

[c] No impact from proposed action as no new leases projected in Wyoming for the low level.

terms of magnitude and duration. The nature of the changes would be the same as those described under the No-Action Alternative, low level, but the effects would be somewhat more intense, extensive, and durable.

Wyoming communities would not be affected by this level.

SURFACE WATER RESOURCES

The proposed action would increase water use by approximately 29,000 ac-ft over present levels as measured on the Colorado River at the inflow to Lake Powell. Increases in depletions (by ac-ft) would be from the following rivers: Colorado, 7,000 ac-ft; lower Green, 9,000 ac-ft; and the upper Green, 20,000; these depletions would result in a 0.5 percent reduction in flow on both the Colorado and Green rivers. Due to these reductions in flow, salinity levels would be expected to increase by 2 mg/l at the mouth of the Green River and at Imperial Dam.

The overall cumulative impacts would be that water depletion would increase by 164,000 ac-ft as measured on the Colorado River at the inflow to Lake Powell. Cumulatively, these depletions would result in the following reductions in flow: 1 percent on the Colorado and Green rivers and 23 percent on the White River as measured at the inflow to Lake Powell, representing about a 2 percent increase in flow reduction.

Due to these reductions in flow, salinity levels would increase 10 mg/l on the White River and 13 mg/l on the Green River. Cumulatively, these represent an 11 mg/l increase in salinity at the inflow to Lake Powell and a 5 mg/l increase at Imperial Dam.

VEGETATION, SOILS, AND AGRICULTURE

The proposed action would result in a disturbance of 8,500 acres, possibly significant at local levels, but not significant at the regional level. The cumulative total of 148,100 acres of disturbance could have local significance. However, the regional significance would not change because the acreage, spread throughout the region, would amount to less than 1 percent of the total regional acreage of more than 27 million acres.

Acreages of soil disturbance would be the same as for vegetation. It is recognized that erosion would occur during construction; however, diversions, structures, and design features can and would be utilized to restrict erosion to acceptable levels under most conditions.

Erosion, as a result of sudden severe thunderstorms, could be severe. If compliance with a reclamation plan did not occur, severe and long-lasting erosion damage could occur.

Loss of agricultural land from conversion to urban development as a result of the proposed action would total 6,181 acres or 0.8 percent of the regional agricultural base, not a significant impact.

The cumulative impact would result in a total of 49,093 acres of agricultural land being converted to urban use, or 6.7 percent of the regional base. This acreage is considered to be a significant impact upon the limited agricultural land in the region because the numbers of ranch and farm units that could go out of business would further reduce the production of winter forage and pasture for livestock.

Grazing losses would occur but are undetermined because numbers of ranches, their locations, or locations of developments are unknown at this time. It is projected that the cumulative impact would be significant.

WILDLIFE

The proposed action would disturb an estimated 8,500 acres of wildlife habitat. Cumulative impact would disturb 148,100 acres of wildlife habitat which is less than 1 percent of the available habitat in the area.

Even though this amount of habitat disturbance is less than 1 percent of the total available habitat in the oil shale region, this percentage could be much greater depending upon the location of future projects. If they were located in critical wildlife areas, disturbance could total much more than 1 percent.

Table 3-15 presents the projected population increases and the resulting proposed action and cumulative impacts on wildife. Increases in consumptive use of wildlife (i.e., hunting, fishing, and trapping) would force the wildlife management agencies of each of the three states to greatly alter its game and fish management strategies by 2000 (see No-Action Alternative, low level, for a discussion of what these changes may consist of).

Changes in management techniques could lead to an increase in illegal killing (poaching) and wanton killing, which is expected to increase (cumulatively) about 87 percent annually over the entire region.

Under this proposed action level, it is estimated that the cumulative impact on flows in the White River would be reduced 23 percent; on the Green River 1 percent; and on the Colorado River, 1 percent. Based upon data in the Biological Opinion for the White River Dam Project (U.S. FWS 1982), any reduction in flows would adversely affect the Colorado squawfish.

RECREATION RESOURCES

The addition of 28,097 people to the oil shale region by the proposed action should not have serious recreational consequences. However, the cumulative impact of an additional 223,151 people above the 1990 baseline population would have significant impacts on the recreation resource. The same type of effects to recreation resources and the quality of the recreation experience would be expected to be similar as analyzed previously in the No-Action Alternative, low level, 2000.

TABLE 3-15

WILDLIFE IMPACTS
Proposed Action, Low Level 2000

State	Population Increase[1]		Increased Pressure on Wildlife(Percent)[2]	
	Proposed Action	Cumulative	Proposed Action	Cumulative
Colorado	21,672	88,248	20	80
Utah	6,335	77,805	10	122
Wyoming	0	57,098	0	80

[1] Over 1980 baseline (see Tables 3-7 and 3-15 for sources).

[2] Represent increase in consumptive and nonconsumptive use and big game/auto accidents.

WILDERNESS

An increase over 1980 of 28,097 persons in the three-state region by the proposed action would not create an appreciable effect on the wilderness resource or quality of the wilderness experience. The management of wilderness units would become more intensive and user pressure would continue to increase slowly in all wilderness units. The cumulative impact of an increase of 223,151 persons would cause an impact to wilderness units which would be similar to those analyzed under the No-Action Alternative, low level, for 2000.

VISUAL RESOURCES

As the proposed action would result in only 8,500 acres being disturbed, the effect on visual resources would be minimal. However, this disturbance would contribute to the cumulative total of 148,100 acres. This cumulative disturbance would cause significant impacts to visual resources. The significant, adverse visual resource impacts would continue to affect the visual character of the region. The impacts would generally be located in VRM Class III and IV areas, with a much smaller amount of the significant visual impacts occurring in VRM Class II areas caused by the expansion of linear systems.

CULTURAL RESOURCES

The proposed action would affect approximately 13 to 72 sites, assuming a regional site density of 1.0 to 5.4 sites per square mile (Weber 1977). Cumulatively, a total of 231 to 1,250 sites may be affected by surface disturbance. These sites could vary in significance from important to National Register quality.

MINERAL RESOURCES

The approximate production of shale oil for this analysis point would be 485,000 bpd over 30 years, representing 4.5 billion barrels of shale oil or 0.26 percent of the recoverable resources in the oil shale region. Of this total, federal leasing actions would be responsible for 120,000 bpd of shale oil production.

TRANSPORTATION NETWORKS

The impacts upon transportation networks from the proposed action cannot be accurately quantified due to lack of information on site-specific projects. However, these impacts would represent an insignificant amount compared to the total cumulative effects from the proposed action and other projects in the region. Consequently, the analyses for the proposed action takes into account the total cumulative impacts to transportation networks, as these impacts constitute the more truer situation.

An estimated 1.34 million daily trips would be generated under this level. Truck and rail traffic would also increase but the amount would depend on marketing by-products and methods for transporting products. This increase of truck and rail traffic could be more than the no action situations due to the proposed action oil shale activity.

Impacts would occur over 1,100 miles of roadway and would be of the same nature as those discussed under the No-Action Alternative, low level, 2000. The impacts would be more severe, however, due to more truck and daily traffic.

High Level

AIR QUALITY

A brief summary of the methodologies and assumptions used to predict air quality impacts is given in Appendix 2.

Air quality modeling results indicate that no National Ambient Air Quality Standards (NAAQS) are violated under this scenario.

The proposed action (leases only) and cumulative (all sources) modeling results are presented in Table 3-16. Figures 3-4 and 3-5 show the predicted cumulative 24-hour concentration isopleths for TSP and SO_2, respectively. It is predicted that the proposed action (leases only) by itself has no significant impacts except for a low potential for consumption of the PSD Class I TSP 24-hour increment and moderate potential for consumption of the PSD Class I SO_2 24-hour increment within the Flat Tops Wilderness. The proposed action contributes small amounts to the cumulative concentrations in two areas which show low potential for consumption of the PSD Class II TSP 24-hour increment, Cottonwood Creek and East Miller Creek. The proposed action contributes insignificant amounts to the cumulative concentrations in the vicinity of the Buckskin Hills, Big Duck Creek, and Big Mountain areas which show a moderate potential for consumption of the PSD Class II TSP 24-hour increment. There is no contribution by the proposed action to an area within Dinosaur National Monument that indicates a low potential for consumption of the PSD Class II TSP 24-hour increment and a moderate potential for consumption of the Colorado Category SO_2 24-hour increment. The proposed action contributes to the cumulative concentrations within Flat Tops Wilderness which indicates moderate potential for consumption of the PSD Class I TSP and SO_2 24-hour increments. The proposed action contributes somewhat to the cumulative concentration within the Mount Zirkel Wilderness which indicates a moderate potential for consumption of the PSD Class I SO_2 24-hour increment. It should be noted that this result for Mount Zirkel Wilderness would not preclude leasing development as the results are largely due to a "non-increment consuming" power plant, for which PSD increment considerations do not apply.

Potential atmospheric deposition for the Class I areas of concern is presented in Table 3-17. While significance criteria for the impacts of acid deposition on air quality-related values (plants, animals, water, soil, cultural, and geologic resources, etc.) in Class I areas do not exist at this time, recent

TABLE 3-16

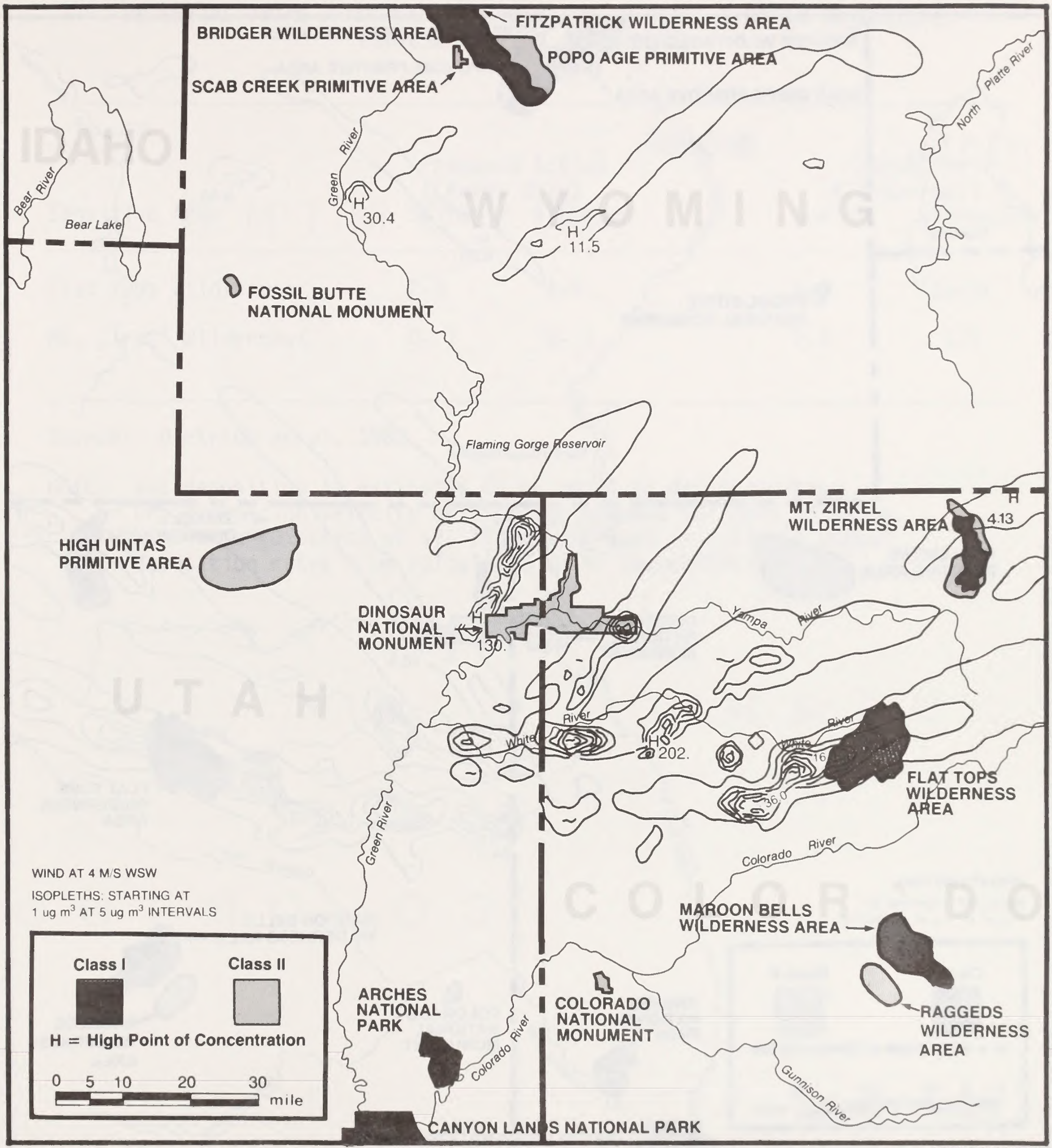
RANGE OF 24-HOUR MODELED POLLUTANT CONCENTRATIONS (ug/m^3)
PROPOSED ACTION, HIGH LEVEL

	2000 High					
	Proposed Action (Leases Only)			Cumulative (All Sources)		
	TSP	SO_2	NO_X	TSP	SO_2	NO_X
Clean Air Act Requirements						
PSD Class I/Colorado Category I 24-hr Increment	10A	5	B	10A	5	B
PSD Class II 24-hr Increment	37	91	B	37	91	B
Sensitive Areas						
Class I Areas						
Flat Tops Wilderness (Colorado)	1-10	1-14	6-56	3-26	4-38	15-150
Mt. Zirkel Wilderness (Colorado)	0->1	0->1	0->1	0-2	1-14	2-16
Colorado Category I Areas						
Dinosaur National Monument (Colorado/Utah)	0	0	0	4-41	2-17	2-15
Class II Areas*						
1. Buckskin Hills (Utah)	0	0	0	13-131	0-5	0-5
2. Baxter Pass (Colorado)	0	0	0	1-8	6-55	5-46
3. Cottonwood Creek (Colorado)	1-13	0-4	6-57	7-72	2-15	29-288
4. Wolf Creek (Colorado)	0	0	0	3-34	5-49	22-216
5. Big Duck Creek (Colorado)	0->1	0->1	0-2	20-203	1-11	14-136
6. Big Mountain (Colorado)	0->1	0->1	0-1	17-167	8-80	40-401
7. East Miller Creek (Colorado)	2-24	3-27	11-112	5-54	6-56	24-241
8. Fontenelle Reservoir (Wyoming)	3-30	0->1	12-122	3-30	0->1	12-122
9. Jack Morrow Creek (Wyoming)	0	0	0	1-12	1-6	1-6
10. Whiskey Peak (Wyoming)	0	0	0	0-1	1-9	2-15

*See Table A-2-4 for detailed locations of Class II Areas

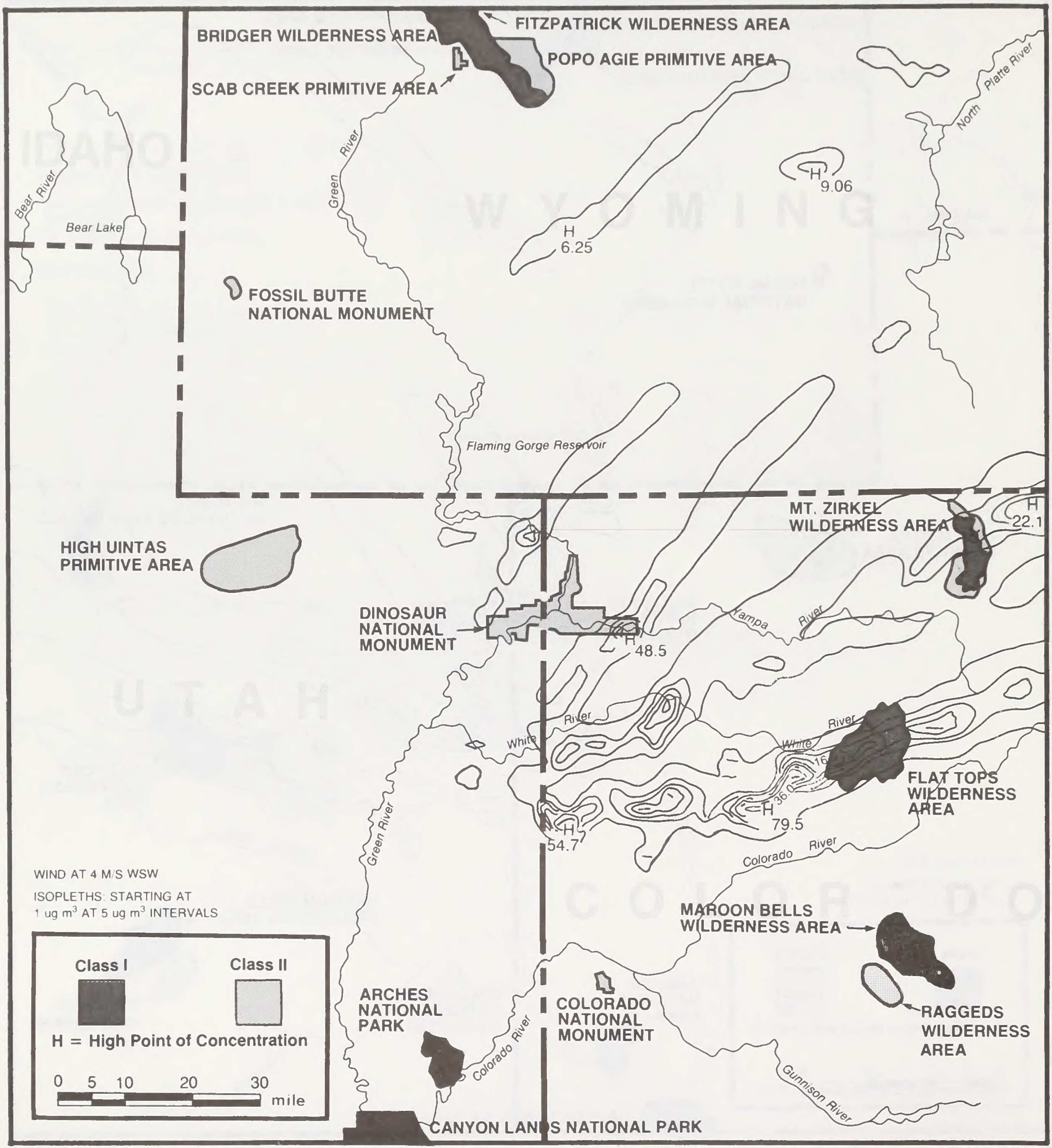
A - Total suspended particulate increments are not included in Colorado Category I standards.

B - There is no Prevention of Significant Deterioration (PSD) increment for nitrogen oxides, but concentrations of these pollutants can affect visibility and acidic deposition.



SOURCE: DIETRICH ET. AL., 1983

FIGURE 3-4 CUMULATIVE 24-HR TSP GROUND LEVEL CONCENTRATIONS, PROPOSED ACTION, HIGH LEVEL, 2000



SOURCE: DIETRICH ET. AL., 1983

FIGURE 3-5 CUMULATIVE 24-HR SO_2 GROUND LEVEL CONCENTRATIONS, PROPOSED ACTION, HIGH LEVEL, 2000

TABLE 3-17

POTENTIAL TOTAL ATMOSPHERIC DEPOSITION ON CLASS I AREAS (kg/ha/yr) PROPOSED ACTION, HIGH LEVEL

	2000 High			
	Proposed Action (Leases Only)		Cumulative (All Sources)	
Sensitive Area	Sulfur	Nitrogen	Sulfur	Nitrogen
Flat Tops Wilderness	2-3	4-9	6-9	15-24
Mt. Zirkel Wilderness	0- 1	0- 1	2-4	1-3

Source: Dietrich et al. 1983

NOTE: Wet deposition is estimated to be equal to dry deposition. Dry deposition velocity of 1 cm/sec assumed for this estimate. Wind data (Dietrich et al. 1983) were used to estimate annual deposition rates from calculated 24-hr concentrations.

information suggests that the current rate of deposition of sulfur in Colorado ranges from 1 to 2 kg/ha/yr (Oppenheimer 1982) and that a rate of 5 kg/ha/yr could be considered as a minimal threshold value for impacts. This would suggest that deposition rates ranging from 3 to 4 kg/ha/yr of sulfur could cause potential impacts. Results of the atmospheric deposition analyses for the proposed action under this scenario indicate that there is a low potential for impacts from sulfur deposition in Flat Tops Wilderness due to the proposed action concentrations and also in Mount Zirkel Wilderness due to cumulative concentrations. There is a moderate potential for impacts in Flat Tops Wilderness due to cumulative concentrations.

Analysis using the EPA Level I Visibility Impact Screening Analysis Method (Latimer and Ireson 1980) indicates that all proposed leasing passes screening except at the 2000 high level scenario for Flat Tops Wilderness (due to Colorado Federal Lease B) and Dinosaur National Monument (due to Colorado Federal Leases A and B). The results show a potential for visibility impacts under this scenario only.

SOCIOECONOMICS

Table 3-18 includes population and employment for this level. The regional cumulative population would be 589,947. The proposed action results in a population increase of 100,188 persons or 41 percent over the 1980 baseline. Cumulative employment would be 271,530 persons. The proposed action would result in an increase of 39,619 or 38 percent over the 1980 baseline. Most of the increase would occur in the Colorado area which would experience a 70 percent addition in population and a 75 percent gain in employment from the proposed action above the 1980 baseline. Such an increase would cause some service and housing shortages in Colorado.

The effects of these increases in jobs and people from the proposed action would be substantial and, when added to the other development projected for the oil shale region, the impacts would be highly significant (140 percent increase in population and 161 percent increase in employment above the 1980 baseline).

QUALITY OF LIFE

The population growth levels associated with this level of leasing and production would have very pronounced community-level social consequences. Population growth pressures on housing; community services such as law enforcement, education, social services; and local administrative functions in Mesa, Garfield, and Rio Blanco counties, Colorado; would be very intense by 2000. The rate of in-migration would result in very unstable communities, with day-to-day uncertainties on the part of residents. This level would result in extensive, severe, and long-lasting community changes throughout the three-county area in Colorado. Relative to the total set of consequences, the effects of the proposed action would be very substantial.

TABLE 3-18

POPULATION AND EMPLOYMENT IMPACTS, Proposed Action, High Level

State	1980		2000			
			Proposed Action		Cumulative	
	Population	Employment	Population	Employment	Population	Employment
Colorado[a]	110,299	53,708	77,298	31,152	278,066	129,225
Utah[b]	63,507	25,131	12,790	5,443	173,214	73,516
Wyoming[c]	71,469	36,875	10,100	3,024	138,667	68,789
Total for Oil Shale Region	245,275	115,714	100,188	39,619	589,447	271,530

[a] Calculated using Planning and Assessment System (PAS) of the Colorado Department of Local Affairs.

[b] Figures devised by applying the following factors to assumed employment figures for possible new lease operations (Source of assumptions: Colorado Department of Highways, 1977):

1. 90 percent direct and indirect work force married, 10 percent single.
2. Average family size for married is 3.25.
3. Employment multiplier = 1.8.
4. Ten percent of employment increases filled locally or by a member of an in-migrant.
5. Thirty percent of secondary jobs filled by spouses.

No impact from proposed action as how new leases projected in Wyoming for low level.

Community effects in Uintah and Duchesne counties, Utah, attributable to the proposed action, would be additive and incremental to the projected baseline. The effects previously described would be of a somewhat greater magnitude and would be extended in time and place but would not be of a fundamentally different nature. These levels of population growth would present very serious problems for residents and officials in these areas. The rate of growth would make successful adaptation, however considered, quite unlikely. Relative to the total set of consequences, the effects of the proposed action at this level in Utah would be moderate and incremental.

This level of production and associated population growth in Lincoln, Uinta, and Sweetwater counties, Wyoming, could lead to moderately severe local community effects by 2000. Communities such as Rock Springs, Evanston, Kemmerer, and Green River would have experienced energy-related growth. Industrialization of these communities has already taken place. Thus, oil shale growth would be incremental above oil-gas, coal and other mineral development-induced changes that have occurred and will occur in the future.

SURFACE WATER RESOURCES

The proposed action would increase water use by approximately 64,000 ac-ft beyond present water use levels as measured on the Colorado River at the inflow to Lake Powell. Increases in depletions (by ac-ft) would be from the following rivers: Colorado, 45,000; lower Green, 13,000; and upper Green, 6,000, resulting in an additional 2 and 1 percent reduction in flows on the Colorado and Green Rivers, respectively, over the reductions in flow at this analysis point without federal leasing. Cumulatively, these reductions in flow would reduce the inflow to Lake Powell by 1 percent. Salinity would increase by approximately 3 mg/l at Imperial Dam.

Water depletions would increase by 368,000 ac-ft due to cumulative effects of the proposed action and other projects as measured at the inflow to Lake Powell. These depletions would result in the following reductions in flow (percent): 2 on the Colorado, 3 on the Green, 40 on the White, and 1 on the Yampa. Cumulatively, these changes in flow would reduce the inflow to Lake Powell by 4 percent.

Due to these flow reductions, salinity levels would increase by 19 mg/l at the mouth of the Green River, 14 mg/l at the inflow to Lake Powell, and 10 mg/l at Imperial Dam.

VEGETATION, SOILS, AND AGRICULTURE

The proposed action would disturb 28,400 acres of vegetation which would not be significant at the regional level, but could be significant at the local level depending upon locations of individual projects.

The cumulative disturbance of 195,400 acres of vegetation, when compared to the 27 million acres in the oil shale region, would be insignificant but could be significant at the local level, if vegetation were considered critical for other resources.

The soil disturbance would be in direct relationship to the vegetative disturbance. Due to required reclamation procedures, in most cases, soil loss should be low. However, if heavy rains or other conditions would not permit reclamation measures to be completed as stipulated, erosion impacts could become significant.

The population increase, as a result of the proposed action, would convert 22,041 acres or 3.0 percent of the agricultural land in the oil shale region to urban use, a low level of significance. However, the cumulative loss would be a total of 75,831 acres, or 10.4 percent of the total agricultural land of the oil shale region, a highly significant level. At the local and regional level, due to the potential for an undetermined number of ranch and farm operations selling their crop and pasture lands for housing and industrial development.

It is anticipated that the loss of pasture and forage production would also have a significant impact upon the livestock industry of the region, although it is not possible to quantify AUM's lost or numbers of livestock operations affected due to a lack of knowledge about specific locations of growth and development.

WILDLIFE

The same amount of wildlife habitat would be disturbed as for vegetation (see vegetation section for this level).

Even though the acreage disturbed totals less than 1 percent of the wildlife habitat in the oil shale region, this percentage could become much greater depending upon the location of future projects. If these projects were located in critical wildlife areas, disturbance could total more than 1 percent.

Table 3-19 presents data on the increase in consumptive, nonconsumptive, and big game/automobile accidents as a result of the proposed action and cumulative impacts.

The proposed action increases vary from 14 percent for Wyoming to 70 percent for Colorado. The cumulative increases vary from 94 percent for Wyoming to 173 percent for Utah.

Increase in consumptive use of wildlife (i.e.; hunting, fishing, and trapping) would force the wildlife management agencies of each of the three states to greatly alter its game and fish management strategies by 2000.

Changes in management strategies could lead to an increase in illegal killing (poaching) and wanton killing. This increase would be in a straight line relationship with the projected population increases.

The increase in automobile traffic in each of the states due to this level of development is expected to increase big game/automobile accidents. Increases in traffic uses could lead to an increase in harassment of some species, resulting in lowered production.

TABLE 3-19

WILDLIFE IMPACTS
Proposed Action, High Level

	Population Increase[a] (2000)		Increased Pressure on Wildlife[b] (Percent)	
State	Proposed Action	Cumulative	Proposed Action	Cumulative
Colorado	77,298	167,767	70	152
Utah	12,790	109,707	20	173
Wyoming	10,100	67,198	14	94

[a] Increase over 1980 baseline (see Tables 3-7 and 3-15 for sources).

[b] Represents increase in consumptive and nonconsumptive uses and big game/auto accidents.

It is estimated that the cumulative average annual flows in the Green River would be reduced 3 percent and flows in the Colorado River would be reduced 2 percent. Any reduction in flow in this river system is anticipated to cause adverse impacts to the Colorado squawfish.

RECREATION RESOURCES

The proposed action would result in a increase of 100,188 persons in the three-state region. The cumulative population increase of 344,688, an increase of 141 percent over the 1980 population level of 245,259, would result in a significant decline in the quality of the recreation experiences. Primitive and semi-primitive forms of dispersed recreation opportunities would have shifted to semi-urban and urban-type dispersed recreation experiences.

Greater use of federal and state lands would also mean increased user conflicts (i.e., off-road vehicle users and hikers) and increased competition for favored dispersed camping sites and day use areas.

Developed facilities would achieve full capacity use with overcrowding likely, especially during the summer. Certain federal and state recreation developments would have to be put to rest in order for the areas to rehabilitate themselves (campgrounds, heavily used day use areas).

The sociological and physical-carrying capacity threshold would be reached on several rivers utilized for river running and hiking trails within the region.

Hunting success ratios would be expected to decline substantially, particularly for big game animals such as deer, elk, and antelope.

Greater hunter competition, contacts, and a dwindling species base would significantly diminish hunting quality within the region.

Urban recreation facilities and local park areas would become overcrowded and need constant maintenance, resulting in a major decline in user gratification. Demands for tennis and racketball courts, swimming pools, local town parks, and the overall benefits provided by community centers would exceed the available supply.

WILDERNESS

The increased population (see Table 3-18) under this level would cause an increase in the impacts to wilderness units which would be similar as analyzed previously in the no action alternative-high level-2000. The proposed action population increase (Table 3-18) could appreciably affect the resource base and quality of a primitive wilderness experience for the users. These adverse effects could compromise the values of various wilderness resource units. Through heavier use of wilderness areas, a daily quota or permit system on most of the wilderness areas in the region would probably be required, for the most part preventing a quality wilderness experience. However, increased visitation to wilderness areas would mean increased incidents of vandalism, a greater amount of litter left behind, more user contacts and conflicts, and a general increase in resource deterioration. Agency work loads would be greatly increased with increased demands for public utilization of the regional wilderness resource base.

VISUAL RESOURCES

The disturbance of 28,400 acres by the proposed action would cause significant impacts to the visual resources, similar to those impacts described in the No-Action Alternative, low level, 2000 analysis; the visual "sense" of the region would show signs of significant, adverse visual modification to the landform, vegetation, and structures found within the region well beyond the contrast of natural landscape features. Humanity's network of new contrasts in landform modification, vegetative pattern changes, and additional structures would qualitatively change the visual resources of the region. Generally, the increased amounts of significant, adverse visual resource impacts would occur in VRM Class III and IV areas, where the oil shale resource is generally located. Expanded linear systems would create additional impacts in VRM Class II areas.

CULTURAL RESOURCES

Assuming a regional site density of 1.0 to 5.4 sites per square mile (Weber 1977), 44 to 240 sites may be affected by the proposed action, and 305 to 1,649 sites affected by the cumulative disturbance; with an increasing number of sites disturbed, the chance for significant impacts would increase.

MINERAL RESOURCES

The approximate production of shale oil at this analysis point would be 1.25 million bpd. Over 30 years, this would represent 12.4 billion barrels of shale oil or 0.73 percent of the recoverable resources in the oil shale region. Of this total, the proposed action would be responsible for 400,000 bpd of shale oil production.

TRANSPORTATION NETWORKS

The impacts upon transportation networks from the proposed action cannot be accurately quantified due to lack of information on site-specific projects. However, these impacts would represent an insignificant amount compared to the total cumulative effects. Consequently, the analyses for the proposed action takes into account the total cumulative impacts to transportation networks, as these impacts constitute the truer situation.

An estimated 1.67 million daily trips would be generated and truck and rail traffic would also increase.

Impacts would occur on 1,100 miles of roadway; the impacts would be most severe and would especially be a problem in Colorado. The impacts would be of the same nature as those discussed forr the No-Action Alternative, low level, 1990.

PROGRAM ALTERNATIVES

Activity Planning Program, Concessionary Leasing Program, and Direct Leasing Program

The environmental impacts of the proposed action (proposed regulations) are considered applicable to the range of possible impacts of the program alternatives. It is recognized in the concessionary approach that there would be a larger area initially committed to oil shlae exploration and lease selection. This creates a potential for surface impacts from exploration over a larger area than the proposed program. Since the direct leasing alternative relies on existing land-use plans without additional land-use or activity planning, the potential for additional impacts is dependent upon the adequacy of the information base in the land-use plans.

Prototype Leasing Program

The impacts of a prototype program would directly relate to the amount of prototype leasing. The same types of impacts analyzed for the proposed action, low and high level, could occur. If the prototype program is continued, it is expected that the amount of leasing would probably most closely follow the assumed low-level analysis for the proposed action.

ENERGY CONSERVATION ALTERNATIVE

Recently, growth in energy consumption and oil imports has declined primarily due to price-related reduction in demand. While new government conservation programs probably could further reduce oil consumption, conservation will probably never be a total substitute for oil. However, it could significantly reduce demand for oil shale and other energy resources. Some examples of energy reduction which could be achieved from the program outlined in Chapter 1 are:

- Fuel savings resulting from increased gas mileage; could be as high as 20 billion barrels covering the years 1995 through 2000.
- Reduction of Btu's from 14,200 per passenger mile for a single occupant automobile, 2,400 for van pools, 3,100 for bus and 5,000 per passenger mile for a commuter rail system.
- Reduction of energy use (unquantifiable) by retrofitting 40 million single-family houses; might require the establishment of 6,000 businesses, each generating at least $400,000 of business annually and many thousands of jobs.

ALTERNATIVE ENERGY FUELS

To the extent that this alternative can reduce oil shale demand, the impacts of energy resource development, including oil shale, would be correspondingly reduced. Congress has taken some initatives in this regard (conservation measures) and some results are apparent, such as reduced demands. This trend is expected to continue. If the proposed action is adopted, this would not preclude a continuing conservation effort.

ALTERNATIVE ENERGY FUELS

The following is a general discussion of impacts from use of the energy sources of oil and coal to offset use of oil shale. Without precise knowledge of the amount or location that increased development would occur in, it is not possible to present specific impacts.

Oil

It is difficult to predict the amount of development of traditional oil sources that would be needed to offset the amount of shale oil that could be produced if the proposed action is implemented. To provide some idea of magnitude, develoment of a 30- to 50-well oil field would be required to offset a 100,000 bbl/day development level (low level) of oil shale. At the projected high level of development (400,000 bbl/day), four times as many wels could be required. On immediate problem would be locating a filed, either onshore or offshore, of that size.

Conventional oil exploration and development results in impacts to all resources. The magnitude and duration of the impacts will be directly related to the size and location of the developmment. Development of the oil fields would cause surface disturbance resulting in impacts to soil, vegetation, wildlife, and recreation and visual resources. Air quality impacts of field development would be expected to be minimal. However, socioeconomic impacts especially during the development phase could be severe. Processing the oil could result in air quality and socioeconomic impacts. Development of the oil resource normally does not result in serious subsurface impacts.

Coal

A similar amount of somewhat comparable fuel could be obtained in the form of methanol from coal liquefaction. To produce the equivalent of 100,000 to 400,000 bbl/day of shale oil would involve the mining and processing of about 10 to 40 million tons of coal per year. This represents one to four large surface mines in the northern Great Plains area (Wyoming, Montana, and North Dakota) and several major liquefaction units.

The extraction (particularly strip mining) and processing of coal creates significant impacts. Reclaiming the land after strip mining could create unique problems. Combustion of coal generates air pollution (i.e., SO_2, NO_x, particulates and hydrocarbons). Acid rain deposition problems associated with combustion of coal in power plants are currently of intense public interest and debate and are the focus of numerous controversial studies. Impacts of liquefaction plants are currently under study by the Bureau of Reclamation. Potential impacts include water consumption, socioeconomics, and air quality.

Environmental impacts, including comparisons of various residuals for different synthetic fuel processes and end use with conventional oil and coal development and use, may be found in Comparative Analysis of Health and Environmental Effects of Coal Conversion Technology (Hamilton et al. 1978).

Impacts of coal development have been analyzed in numerous EISs, some of the most recent being Development of Coal Resources in Southwestern Wyoming Final EIS, BLM 1978d; the Green River Hams Fork Draft Coal EIS, BLM 1980c; and Federal Coal Management Program Final EIS, BLM 1979. Development of the coal resource is being pursued simultaneously with oil shale.

CHAPTER 4
COMPARATIVE ANALYSIS

INTRODUCTION

Chapter 4 addresses major differences between the impacts of the proposed action and the No-Action Alternative. The impact of the program alternatives (see Chapter 3), activity planning, concessionary leasing, direct leasing, and prototype leasing would fall within the range of impacts analyzed for the proposed action and No-Action Alternative. The level of leasing that would occur under each alternative would determine the level of impacts. This covers both low and high levels of projected development for 2000 only, since it was assumed (see Chapter 3) that there would be no operational impacts for the proposed action in 1990. Impacts of the No-Action Alternative only were discussed in Chapter 3. Table 4-1 summarizes the quantifiable differences in impacts by resources. Significant differences in other resource and non-resource items are discussed in qualitative terms in respective sections.

This analysis compares the possible unavoidable adverse impacts at various levels of oil shale development that could take place under the proposed action and alternatives. The adoption of the proposed action (i.e., permanent oil shale management program with attendant regulations) would be only the first step in a leasing program and would not directly result in any unavoidable adverse impacts. It should be noted that under any of the permanent program options, specific tracts would be identified, and site-specific National Environmental Policy Act (NEPA) compliance before leasing would provide more precise identification and quantification of actual impacts.

AIR QUALITY

With no action, low level, 2000, the analysis of emissions from all projects shows a potential consumption of the Class II Prevention of Significant Deterioration (PSD) total suspended particulates (TSP) increment for the Buckskin Hills area in Utah and Big Duck Creek and Big Mountain areas in Colorado. The analysis also projects a potential consumption of the Class I PSD sulfur dioxide (SO_2) 24-hour increment levels to occur in the Flat Tops Wilderness Area. The Colorado Category I SO_2 and the PSD Class II TSP 24-hour increments may also be consumed within Dinosaur National Monument.

Analysis of the proposed action, 2000 cumulative impacts indicates that, even at low-level development, there is potential for consumption of the Class II PSD TSP 24-hour increment level for the Buckskin Hills, Big Duck Creek, and Big Mountain areas. The analysis also shows potential consumption of the Class I PSD SO_2 24-hour increment in the Flat Tops Wilderness Area, Colorado Category I SO_2 and PSD Class II TSP 24-hour increments within Dinosaur National Monument, the same as the No-Action; thus, there is little difference between the No-Action Alternative and proposed action with respect to potential Class I increment consumption.

TABLE 4-1

DIFFERENCES IN IMPACTS BETWEEN NO-ACTION AND PROPOSED ACTION IN 2000

	No Action		Proposed Action[1]		Differences	
	Low	High	Low	High	Low	High
RESOURCE						
Air Quality[2]						
Class I						
Flat Tops (Colorado)						
TSP (ug/m^3)	6	16	9	26	+ 3	+ 10
SO_2 (ug/m^3)	9	24	13	38	+ 4	+ 14
Class II						
Buckskin Hills (Utah)						
TSP (ug/m^3)	131	131	131	131	0	0
Big Duck Creek (Colorado)						
TSP (ug/m^3)	101	202	101	203	0	1
Big Mountain (Colorado)						
TSP (ug/m^3)	68	167	68	167	0	0
Cottonwood Creek (Colorado)						
TSP (ug/m^3)	29	59	35	72	6	13
East Miller Creek (Colorado)						
TSP (ug/m^3)	13	30	20	54	7	24
Water Resources (surface)						
Flow (ac-ft/yr x 1000)	-135*	-304	-164*	-368*	-29	-64
Salinity (mg/l)	3**	7**	5**	10**	2**	3**
Vegetation, Wildlife Habitat						
Acres Disturbed	139,580	167,000	148,100	195,400	+8,520	+ 28,400
Agriculture						
Acres Removed from Production	42,912	53,790	49,093	75,831	+6,181	+ 22,041
Cultural Resources						
Sites Affected by Surface Disturbance						
at 1.0 site/sq. mi	218	261	231	305	+13	+44
at 5.4 site/sq.mi	1,178	1,409	1,250	1,649	+72	+240

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*On Colorado River at inflow to Lake Powell.

**At Imperial Dam on Colorado River.

[1] Impacts shown are cumulative.

[2] Worst case impacts are shown. Range of impacts for both Class I and Class II areas and Colorado Category I are presented in Tables 3-6, 3-9, 3-12, and 3-14.

Air quality impacts for the No-Action Alternative 2000, high-level projections are similar to the low-level projections: (1) consumption potential of the Class II PSD TSP 24-hour increment in the same three areas (Buckskin Hills, Utah and Big Duck Creek and Big Mountain, Colorado) plus Cottonwood Creek, Colorado area, (2) consumption of the Class I PSD TSP increment as well as the SO_2 increment in in the Flat Tops Wilderness Area, and (3) consumption of the Colorado Category I SO_2 and PSD Class II TSP 24-hour increments within Dinosaur National Monument.

For the proposed action high level, the same four PSD Class II areas cited for the no-action plus the East Miller Creek area in Colorado potentially exceed the Class II PSD TSP 24-hour increment level. The same impacts for Dinosaur National Monument are also predicted. With no further federal leasing, there would be some differences in the air quality impacts in 2000 between the low- and high-level development (see Tables 3-6 and 3-12).

The proposed action, high level, would potentially consume the Class I PSD SO_2 and TSP increments in the Flat Tops Wilderness Area Colorado. The cumulative impact analysis indicates the PSD Class I TSP and SO_2 increments would be potentially consumed for the Flat Tops Wilderness Area. Visibility impacts are possible for Flat Tops Wilderness Area, Mount Zirkel Wilderness Area, and Dinosaur National Monument under only the proposed action, high level.

SOCIOECONOMICS

The proposed action, low level, 2000 (see Table 4-1) would increase the population by approximately 28,000 persons through the creation of approximately 11,000 new jobs over the increases projected for the No-Action Alternative, low level, 2000. The proposed action, high level, 2000 would increase the population by approximately 10,000 persons through the creation of approximately 40,000 new jobs over the increases projected for the No-Action Alternative, high level, 2000. The regional population (proposed action, high level) is projected to increase by 140 percent over the 1980 baseline, with the majority of the population impacts occurring in western Colorado where the bulk of the energy development is projected to occur. The increase for the high level caused by the proposed action would add to the already severe population impacts.

Additional jobs would have beneficial effects on local economies, while more people would place substantial financial burdens on local governments to provide needed services and facilities (see the following Quality of Life section).

QUALITY OF LIFE

Population growth projected from 1990 to 2000 for the no-action levels would cause substantial and extensive social changes in western Colorado and significant impacts for communities within the Uinta Basin in Utah. Housing would be in short supply and heavy pressure would be placed on law enforcement and education facilities. Crime, family instability, alcohol and drug abuse, and other community disruption would increase at rates equal to or greater than population growth.

The population growth stemming from the proposed action, high and low levels in 2000 are additive and would cause even more pronounced impacts on housing, community services (law enforcement, education, and social services), and local administrative functions. Population growth pressures would be very intense in Mesa, Garfield, and Rio Blanco counties in Colorado by 2000. The actual magnitude of these impacts would be based on the actions of the state government to require mitigation by the involved companies.

SURFACE AND GROUND WATER RESOURCES

Prediction of specific ground water impacts was not possible at the programmatic level of analysis. Differences in impacts between the proposed action and the No-Action Alternative were not analyzed due to lack of specific data. Broad and generalized impacts of oil shale development on ground water can be found in the general impact section of Chapter 3. The site-specific impacts would be analyzed during the preparation of the EIS for the lease sales.

At the No-Action, low 2000 level, streamflow would decrease by a cumulative 128,000 ac-ft/yr at the inflow to Lake Powell as a result of increased water use. Streamflow would decrease by a cumulative 164,000 ac-ft/yr for the low level, proposed action, a difference of 36,000 ac-ft/yr attributable to federal leasing. The cumulative impact for all development associated with the low level, proposed action represents a 2 percent reduction in streamflow for the Colorado River at the inlow to Lake Powell, whereas the streamflow reduction attributable to federal leasing is less than 0.5 percent. Due to these reductions in flow, salinity levels would increase to 5 mg/l at the inflow to Lake Powell.

At the no-action, high level, in 2000 streamflow would decrease by 304,000 ac-ft/yr on the Colorado River at the inflow to Lake Powell. It would decrease by 368,000 ac-ft/yr due to the cumulative effects of the proposed action at the same point. This represents a 4 percent reduction in streamflow in the Colorado River at the inflow to Lake Powell, the cumulative impact of the developments under the proposed action. The difference of 64,000 ac-ft/yr reduction in streamflow represent approximately a 1 percent decrease associated with the high level of federal leasing. Salinity levels on the Colorado River increase by 7 mg/l and 10 mg/l for the no-action and proposed action high levels due to the reduction in streamflows. Impacts to the tributaries of the Colorado River presented in Chapter 3 are substantially higher than to the main stream of the Colorado River, but are not repeated here.

AGRICULTURE

Approximately 43,000 acres of agricultural land is projected to be converted into non-agricultural uses under the No-Action Alternative, low level, and approximately 49,000 acres under the proposed action, low level for 2000, which represents 6 percent and 7 percent of the agricultural land base in the region. Because of the lack of agricultural lands in the region, this would be a significant impact on the resource.

The degree of impact on agricultural land from the cumulative impact of the proposed action should be expected to be substantial, depending on the type of land removed from production (irrigated cropland and grazing lands), its location and the potential of the remaining lands for alternative or more intensive agricultural use.

Approximately 54,000 acres of agricultural land is projected to be converted into non-agricultural uses under the no-action, high level, and about 76,000 acres under the proposed action, high level, in 2000, which represents 7 percent and 10 percent of the agricultural land base, respectively. Approximately 22,000 acres or 3 percent of the agricultural land base in the oil shale region would be removed from production by the proposed action, high level. The degree of impact on agriculture would be substantial and highly significant at the local and regional levels, depending upon the type of land removed from production (irrigated cropland and grazing lands), its location, and the potential of the remaining lands for alternative or more intensive agricultural use.

WILDLIFE

At the low level for no-action, 2000, approximately 140,000 acres of wildlife habitat would be disturbed. At the low level for the proposed action, wildlife habitat disturbance increases to 148,000 acres. The 8,000 additional acres disturbed by low-level federal leasing would not, in itself, be significant from a regional perspective, because the total 148,000 acres of wildlife habitat disturbed by the low level cumulative development for 2000 represents less than 1 percent of the aggregate vegetative habitat available in the oil shale region. However, critical wildlife habitat losses could occur in specific geographic areas and will be assessed in the land-use planning process.

The total amount of wildlife habitat which would be disturbed in 2000 under the no-action, high level would be approximately 167,000 acres and approximately 195,000 acres under the proposed action, high level. The 28,000 additional acres of wildlife habitat disturbed by the high level of federal leasing constitutes less than 1 percent of the available vegetative habitat available in the oil shale region. However, critical wildlife habitat losses could occur in specific geographic areas and will, therefore. be addressed in the land-use planning process.

Significant increases in both consumptive and non-consumptive uses of wildlife (hunting, fishing, bird-watching, etc.), brought about by substantial population growth associated with energy development by 2000, would cause significant impacts on wildlife throughout the region.

Impacts on rare and endangered species will be expected to occur in the same proportion as with other species because of loss of habitat and population growth. As specific projects are undertaken, evaluations will be made in conjunction with the requirements of the Rare and Endangered Species Act.

SAFETY AND HEALTH AND HAZARDOUS WASTE

Because of the lack of specific data on which to base the impact analysis, it was not possible to predict differences in impacts between the proposed action and No-Action Alternative for these subject areas. Therefore, it is not possible to compare impacts. A general discussion of possible safety and health and hazardous waste impacts may be found in the genreal impact section of Chapter 3. Specific analysis would occur at the site-specific level of EIS preparation. Lessees would have to comply with Occupational Safety and Health Administration (OSHA) and Mine Safety and Health Administration (MSHA) regulations related to their refinery and mining processes. They would also have to comply with the Resource and Conservation Recovery Act of 1976.

RECREATION RESOURCES AND WILDERNESS

With the regional population projected to double by 2000 under the no action, high level, impacts on dispersed recreation facilities would be greatly increased and could cause a substantial decrease in the quality of recreation experiences unless these pressures are offset by restrictive management measures and large investments. Demand for wilderness recreation experiences is projected to increase in a similar fashion. The expected impact would include a decline in the quality of the primitive recreation experiences and a possible shift in recreation use to areas previously considered less popular.

With a population increase of 100,000 projected as a result of the proposed action, high level in 2000, impacts on dispersed and primitive recreation use would be even more severe than those discussed under the no-action, high level. The quality of the recreation and wilderness experiences would continue to decline without substantial infusions of management and money. The recreational opportunities and wilderness experiences which are presently available within the region would not exist in the same way in 2000 under the proposed action, high level, assuming there would be no major shift in recreation preferences.

CULTURAL RESOURCES

Under the no-action, low level in 2000, 218 to 1,178 sites may be affected by surface disturbance, increasing to 231 to 1,250 sites under the proposed action, low level in 2000. The difference of 13 to 72 sites represents the number of sites that could be disturbed as a result of a low level of federal leasing.

With the acreage disturbed from oil shale and other developments in the region plus agricultural land conversion caused by population growth, 261 to 1,409 sites may be affected by surface disturbance under the no-action, high level, in 2000.

Under the proposed action, high level, in 2000, 305 to 1,649 sites may be cumulatively affected by the total surface disturbance. Approximately 44 to 240 cultural sites may be lost due to additional federal leasing.

The projected loss of cultural resource sites due to increased surface disturbance will be significant in the oil shale region. The land-use planning process would further delineate geographic areas of potential site damage, as well as narrow the range (number) of sites which would be lost.

TRANSPORTATION NETWORKS

The impacts upon transportation networks from the proposed action cannot be accurately quantified due to lack of information on site-specific projects. However, these impacts would represent an insignificant amount compared to the total cumulative effects. Consequently, the analyses for the proposed action takes into account the total cumulative impacts to transportation networks, as these impacts constitute the truer situation. Impacts on road quality and level of services would occur on 1,100 miles of roadway, and would be especially severe in western Colorado.

VISUAL RESOURCES

For the no-action, low level, 2000, an estimated 140,000 acres would be disturbed; for the proposed action, low level, this increases to 148,000 acres, the difference of 8,000 additional acres attributable to federal leasing. Significant adverse visual resource impacts would increase proportionately with the increased disturbed acres and would continue to affect the visual character of the region. The bulk of the impacts would generally be located in VRM Class III and IV areas (see Chapter 2 for discussion and definition).

Significant impacts to the visual resource would be proportionately greater than those determined for the no-action, high level, as a result of implementing the proposed action, high level.

COMPARATIVE ANALYSIS-VISUAL RESOURCES

An additional 28,000 acres would be disturbed as a result of implementing the proposed action, high level, or about 195,000 cumulatively disturbed acres in the region. The visual "sense" of the region would show signs of significant adverse visual modification to the landform, vegetation, and structures found in the region well beyond the contrast of natural landscape features. Generally, the increased amounts of significant adverse visual resource impacts would occur in VRM Class III and IV areas where the oil shale resource is generally located, but to a greater degree than in the low-level situation.

CHAPTER 5
LONG-TERM ENVIRONMENTAL CONSEQUENCES

INTRODUCTION

The proposed action as described in Chapter 1 is the adoption of a program for long-term leasing of federal oil shale reserves. This would include implementing regulations to carry out the program. Adoption of the program does not automatically result in the irreversible or irretrievable commitment of resources or set into motion any long-term environmental consequences. The level of leasing which occurs under the program would establish the level of commitment of resource and long-term environmental consequences. These impacts would be analyzed in detail in the resource management plan EIS's and other site-specific NEPA compliance procedures which would precede actual leases. The discussion in theis chapter deals with the commitments that would occur based on the assumed levels of development for the proposed action.

IRREVERSIBLE - IRRETRIEVABLE COMMITMENT OF RESOURCES

Cultural resources are considered irreversibly or irretrievably lost if artifacts or sites are accidentally destroyed during construction. Due to site densities in the region, there is a distinct possibility of a loss of from 44 to 240 sites. The oil shale resource is also used, and would not be available for later needs once mining and extraction of shale oil occur. The possibility exists that other mineral resources may be left unavailable to future use under the spent shale piles. Due to population trends, agricultural land that would be removed from production through the conversion of land to non-agricultural use would be considered irreversible and irretrievable. Alteration of the natural landscape through construction filling of depressions and canyons with spent shale and land use conversion would cause an irreversible loss of wildlife habitat and a visual change to the landscape.

RELATIONSHIP BETWEEN SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE OF LONG-TERM PRODUCTIVITY

Air quality impacts would constitute a short-term (30-year life of the project) use of the air resources which could place a restriction on other nearby developments. Permanent conversion of 22,000 acres of crop and pasture lands to urban use could reduce long-term production of agricultural commodities in the region. Vegetation losses of 28,000 acres, along with its wildlife habitat losses, would be short term in areas where reclamation and revegetation practices would be implemented during the life of the project. Significant visual contrasts created by construction of access roads, transmission lines, and facility structures (some of which would be permanent) would change VRM Classes III and IV to Class V for the long term since rehabilitation practices would be necessary to return the landscape to its original visual classification. Water utilization for shale oil production would be short term (life of the project) but could affect the long-term agricultural production of the area by selling the land for other uses because of the unavailability of water for agricultural purposes.

LONG-TERM ENVIRONMENTAL CONSEQUENCES

In summary, the proposed action could require a commitment of certain human and environmental resources of the oil shale region to develop the Nation's long-term energy productivity. Some of these commitments are local in nature and short term (lasting approximately 30 years, the life of the project). Other commitments are long term as they are related to the industrial development of the region.

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[a]Available through public libraries' loan system.

[b]Available from Bureau of Land Management (BLM), Division of EIS Services, 555 Zang Street, Third Floor East, Denver, Colorado 80228.

[c]Available from BLM District or State Offices.

The appropriate symbols will appear at the end of each citation.

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GLOSSARY

Aboveground (surface) retorting - Any process in which oil shale is mined and brought to surface facilities for the extraction of shale oil.

Acre-foot (ac-ft) - The volume of water that would cover 1 acre to a depth of 1 foot, equal to 325,853 gallons.

Alluvium - Clay, silt, sand, gravel, or other loose stream-deposited material.

Ancillary Facilities - Structures (compressor stations, power, and communication lines, cathodic protection systems) which are necessary for the continuous operation or maintenance of the project.

Animal Unit - One cow, one horse, one burro; five sheep or goats -- all being over 6 months of age.

Animal Unit Month - The amount of forage a cow and a calf (6 months of age and under) would consume in 1 month. This unit is used to calculate carrying capacity and serves as a basis for grazing fees.

Aquifer - An underground formation containing water.

Atmospheric Dispersion Model - A mathematical simulation of the atmospheric transport and dispersion of pollutants used to predict pollutant concentrations.

Barrel of Oil - 42 U. S. gallons.

Climate - The statistical collective of an area's weather conditions during a relatively long interval of time (usually several decades).

Critical Area - An area of habitat that is essential to the survival of any wildlife species sometime during its life cycle.

Devonian Oil Shale - These marine shales originated from humic and saprolitic deposits in the Chattanooga Sea during the late Devonian and the early Mississipian times (330 to 360 million years ago). The Black Devonian shale is composed mainly of illite. The shale is located in Kentucky, Tennessee, Michigan, Ohio, Indiana, Illinois, and Alabama.

Dip - Angle at which a stratum or any plan or feature is inclined from the horizontal.

Direct Heated Retorts - See direct retorting.

Direct Retorting - An oil extraction method using direct heating of shale by the combustion of carbon, gas, and air within the retort.

Dispersion Potential - The ability of the atmosphere to dilute or disperse air pollutants as determined by normal ventilation values. A high dispersion potential results from high ventilation values, which can be caused by high transport wind speeds, high mixing heights, or high values of both.

Forb - A low growing broadleaf plant.

Green River Formation - One of the richest deposits of oil shale in the world, located in northwestern Colorado, east central Utah, and southern Wyoming. The geology suggests that the deposits were formed by tons of organic and inorganic materials deposited on the bottom of vast prehistoric lakes during the Eocene Age, some 50 million years ago.

Hydrocarbons - Any one of a very large class of chemical compounds composed primarily of carbon and hydrogen. The largest single source of hydrocarbons today is petroleum crude oil.

Indirect Retorting - A retorting method in which heat is transferred to the shale by gases heated outside the retort vessel.

In Situ Retorting - Any process in which a section of oil-bearing shale is heated in place, underground, to release oil without any significant mining of ground materials.

Inversion - A departure from the usual decrease in temperature with altitude, typically a warm layer of air over a cooler layer of air.

Kerogen - The organic, oil-yielding material present in oil shales. Kerogen is not a definite compound but a complex mixture varying from one shale to another. When heated to above 900°F, kerogen decomposes to yield a liquid oil, light gases, and a solid residue.

Leaching - The separation of dissolving of the soluble constituents from a rock or ore by chemical solutions or water.

Locatable Mineral - USGS Bulletin 537 classification of the Public Lands 1913, defines a locatable mineral as follows, "a showing of mineral as would warrant a person of ordinary prudence in expending his time and labor upon the claim in the reasonable hope and expectation of developing a paying mine thereon."

Mahogany Zone - A layer of oil shale in the Parachute Creek Member of the Green River Formation yielding up to 70 gallons of oil per ton.

Modified In Situ Retorting (MIS) - A process in which a portion of the shale deposit is removed from underground and the remaining oil shale is fractured to create a highly permeable zone to allow passage of air and fire to heat the kerogen and release the shale oil.

NAAQS - National Ambient Air Quality Standards. These standards establish the absolute national limits for pollutant concentrations (primary - human health, secondary - public welfare).

Off-Road Vehicle (ORV) - A vehicle (including four-wheel drive, trail bikes, snowmobiles, etc., but excluding helicopters, fixed-wing aircraft, and boats) capable of traveling off-road over lands, water, ice, snow, sand, marshes, etc.

Oil Shale - A layered sedimentary rock which contains abundant quantities of an organic material known as kerogen. When heated above 900^{o}F, the kerogen in the rock decomposes, releasing a liquid oil product, shale oil.

Open Pit Mining - A process in which the overburden, or surface, and other covering material is drilled and blasted over a large area and removed to expose beds of oil shale. The shale is then drilled, blasted, and removed.

Overstory - A layer of vegetation, usually shrubs or trees, that forms a secondary layer of vegetation.

Pasquill Stability Class E - The stability category which corresponds to nighttime meteorological conditions with less than 3/8 cloud cover and surface winds between 2 and 5 meters per second.

Perched ground water - Ground water separated from an underlying body of ground water by unsaturated rock.

Piceance Basin - A 1,500-square mile area in Garfield and Rio Blanco counties of northwestern Colorado containing a vast concentration of oil shale deposits. The total resource is estimated to contain more than a trillion barrels of oil.

Prevailing Wind - The most frequent compass direction from which the wind blows.

Prevention of Significant Deterioration (PSD) - The management concept of establishing more stringent pollution increment levels in areas with clean air. PSD increments limit the amount of **additional** sulfur dioxide and total suspended particulate concentrations. Geographic areas are divided into three classes - each allows different increments of TSP and SO_2 concentration increases.

Class I - minimal additional deterioration in air quality (certain national wilderness areas).
Class II - moderate additional deterioration in air quality (most lands).
Class III - greater deterioration for planned maximum growth (industrial areas).

Prototype Leasing Program - A leasing program begun June 4, 1971, designed to encourage oil shale development while providing for environmental protection.

Pyrolysis - The breaking down of chemical bonds by the application of heat. The thermal decomposition of heavy hydrocarbon molecules to yield lighter species.

Refining - The chemical and physical process by which raw or crude petroleum is separated into its various components and chemically changed to desirable products such as gasoline and heating oil.

Reserve - Those portions of a resource that can be extracted from a deposit and processed to yield products that can be marketed at a profit.

Resource - A naturally occurring substance with useful properties (see reserve).

Retort - Any closed vessel or facility for heating a material in shale oil operations; the vessel or container in which the kerogen in the oil shale is pyrolyzed to recover the shale oil.

Retorting - The process by which a material, such as oil shale, is heated to pyrolysis temperatures of 900°F or more to obtain crude shale oil.

Room-and-Pillar Mining - A process in which some of the oil shale deposit is removed from underground rooms for above ground retoring. Some of the deposit is left in place in the form of pillars to support the mine roof.

Rubbling - The process of breaking large, solid materials into rough, broken stones. As applied to oil shale technology, the process in which the shale within a given volume is explosively fractured into a mass of small pieces (see modified in situ retorting).

Scottish Retort Process - Most of the first shale retorts in Colorado were designed on the Scottish Retort Process. This type of retort was vertical shale which was fed by gravity through a hopper. The upper part of the retort was used for extracting oil vapors and the lower part of the retort, where oil shale was heated to maximum temperature, was used to extract ammonia gas.

Shale Oil - The liquid oil produced from heating oil shale rocks. Shale oil is a synthetic crude oil resembling conventional petroleum.

Spent Shale - The material remaining after oil and gas products are removed by retorting; properties vary with the type of retorting procedure used. Indirectly heated retorts produce a carbonaceous spent shale; directly heated retorts eliminate carbon residue.

Strip Mining - The mining of coal by surface mining methods as distinguished from the mining of metalliferous ores by surface mining methods, which is commonly designated as open pit mining.

Synthetic Crude Oil (Syncrude) - A substance produced by adding hydrogen to crude shale oil, comparable with the best grades of conventional crude oil.

Synthetic Fuel (Synfuel) - Any direct substitute for liquid petroleum fuels. Liquid petroleum - like fuels derived from so-called "unconventional" non-petroleum sources such as coal, oil shale, tar sands, agricultural products, or municipal solid wastes.

Synthetic Fuels Corporation - Created by the Energy Security Act to meet synthetic fuel production goals. The corporation was designed to offer loan guarantees, price supports, and purchase agreements to developers of commercial-scale synthetic fuel projects.

Tasmanite - These marine shales originated from deposits of algal spores. The deposits occur in pods several feet long, and 1 or 2 feet thick. While the distribution is not broad, the deposits are very rich. Deposits in the United States are located in Alaska.

Tertiary Oil Shale - Originated from deposits in two fresh water lakes, Lake Uinta and Lake Gosiute during the Eocene Age (50 million years ago). Tertiary shales are chiefly composed of marlstone and are located in Colorado, Utah, and Wyoming, and in scattered deposits in Montana, Nevada, and California.

Trona - A hydrated mixture of sodium carbonate and sodium bicarbonate. Trona is a source of soda ash for glass production.

True In Situ (TIS) - An oil production process in which the shale is left underground, heated by injection of hot fluids and oil is drawn off through wells.

Understory - An underlying layer of low-growing vegetation.

Vegetation Type - Various combinations of species which have similar stature and appearance and which dominate or appears to dominate a site.

Visibility - A measurement of the maximum distance to which large objects may be viewed. Fixed reference objects such as mountains, hills, towers, or buildings are normally used to estimate visibility.

Wet Adiabatic Lapse Rate - The standard rate of decreasing temperature of moist air with increasing altitude (at constant pressure and density).

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APPENDIX 1
CONSULTATION AND COORDINATION

APPENDIX 1-A

Public Involvement In EIS Scoping Process

The first step in preparing an environmental impact statement (EIS) is called "scoping." The scope of an EIS is the range of actions, alternatives, and impacts to be included in the document; the purpose is to determine the significant issues related to a proposed action which should be included in the EIS. Its basic goal is to make environmental impact statements more meaningful to persons in the federal government who must make decisions on the proposal, as well as to the people who may be affected by approval or disapproval of the proposal or its alternatives.

The Bureau of Land Management (BLM) sponsored six public meetings designed to involve interested citizens and groups in the scoping process. All public meetings were announced in the Federal Register and were held at the locations shown below. The dates of the meeting and attendance are also shown.

Location	**Date**	**Attendance**
Denver, Colorado	Monday, February 1, 1982	82
Salt Lake City, Utah	Tuesday, February 2, 1982	24
Vernal, Utah	Wednesday, February 3, 1982	26
Rock Springs, Wyoming	Wednesday, February 3, 1982	13
Meeker, Colorado	Thursday, February 4, 1982	30
Grand Junction, Colorado	Friday, February 5, 1982	54

After the scoping meetings were held, BLM personnel analyzed the issues raised at the meetings and found that public concern centered on four issues: socioeconomics, quality of life, air quality, and water resources.

A detailed report on the EIS scoping process, "Programmatic EIS Scoping Report: Federal Oil Shale Management Program," can be obtained from the Bureau of Land Management, Division of EIS Services, First Floor East, 555 Zang Street, Denver, Colorado 80228. Among other things, it includes the list of issues raised at each meeting, scoping meeting participants, and a discussion of the procedures used to analyze the scoping meeting data.

APPENDIX 1-B

Consultation And Coordination

The agencies and groups that will receive a copy of the DEIS for comments are as follows:

FEDERAL GOVERNMENT AGENCIES

Advisory Council on Historic Preservation

Department of Agriculture

- Forest Service
- Soil Conservation Service

Department of Defense

- U.S. Army Corps of Engineers

Department of Energy

Department of the Interior

- Bureau of Indian Affairs
- Bureau of Mines
- Bureau of Reclamation
- Fish and Wildlife Service
- Geological Survey
- Minerals Management Service
- National Park Service

Department of Transportation

- Federal Highway Administration

Environmental Protection Agency

Interstate Commerce Commission

LOCAL GOVERNMENTS[a]

Various governments within the affected area.

STATE GOVERNMENTS AND AGENCIES

Colorado

- A-95 Clearinghouse

Utah

- A-95 Clearinghouse

Wyoming

A-95 Clearinghouse

COPIES MAY BE INSPECTED AT THE FOLLOWING BUREAU OF LAND MANAGEMENT OFFICES:

Division of Coal, Tar Sands, and Oil Shale, 18th & C Streets, N.W.	Washington, D.C. 20240
Division of EIS Services, 1st Floor East, 555 Zang Street	Denver, Colorado 80228
Colorado State Office, 1037 20th Street	Denver, Colorado 80202
Utah State Office, University Club Building, 136 E S. Temple	Salt Lake City, Utah 84111
Wyoming State Office, 2515 Warren Avenue, P.O. Box 1828	Cheyenne, Wyoming 82001

[a] Detailed list available from the Bureau of Land Management, Division of EIS Services, 555 Zang Street, First Floor East, Denver, Colorado 80228; phone: (303) 234-6737

APPENDIX 2

METHODOLOGIES

AIR QUALITY

The methodologies and assumptions used to predict air quality impacts in this environmental impact statement (EIS) are briefly summarized from the Air Quality Technical Report for the Federal Oil Shale Management Program and Table A-2-1 (Dietrich et al. 1983). The technical report may be obtained from Jack Edwards, Project Leader, Division of EIS Services, Bureau of Land Management, 555 Zang Street, First Floor East, Denver, Colorado 80228; phone (303) 234-6737.

In order to determine the contribution a Federal Oil Shale Management Program would make to air quality impacts, pollutant concentrations were estimated using the Topographic Air Pollution Analysis System (TAPAS). TAPAS is a system composed of several air quality-related computer models, principally WINDS and CITPUFF (Childs and Marlatt 1981). The WINDS model simulates the wind flow in complex terrain based on topography, surface roughness, and meteorological boundary conditions. The CITPUFF model is a Gaussian Puff air pollution transport and dispersion model that uses the derived wind field, source emission data, topography and meteorological boundary conditions to estimate ground level pollutant concentrations downwind of individual or multiple sources.

TAPAS was employed to determine worst-case pollution concentrations throughout the air quality study area, particularly from long range transport over complex terrain to pristine areas. The following steps were necessary during the analysis:

- Specification of the air quality study area to include oil shale operations in Colorado, Utah, and Wyoming, significant non-oil shale major emitting sources; and sensitive receptors such as Class I areas;
- Wind field analysis to determine worst-case meteorological transport conditions;
- Transport and dispersion modeling of source emissions dependent upon modeled wind fields;
- Scaling various sources under the analysis scenarios to determine predicted ground level concentrations;
- Application of screening techniques to modeling results in order to quantify the potential for visibility degradation and atmospheric deposition which are considered to be indicators for adverse changes to air quality related values (AQRV's) in existing and proposed Class I areas (Fox et al. 1982). AQRV's are generally identified as flora, fauna, soil, water, visibility, odor, and cultural and geologic resources, etc.

TABLE A-2-1

FEDERAL AND STATE AIR QUALITY STANDARDS (micrograms per cubic meter - ug/m^3)

		Federal Standards										
				PSD Increments[c]								
		Ambient[b]		Class	Class	Class	Colorado Standards		Utah Standards		Wyoming Standards	
Pollutant	Averaging Time[a]	Primary	Secondary	I	II	III	Primary	Secondary	Primary	Secondary	Primary	Secondary
Sulfur Dioxide	Annual	80	---	2	20	40	80	---	80	---	60	---
	24-Hour	365	---	5	91	182	365	---	365	---	260	---
	3-Hour	---	1,300	25	512	700	---	1,300	---	1,300	---	1,300
Total Suspended Particulates	Annual	75	60	5	19	37	75	60	75	60	60	---
	24-Hour	260	150	10	37	75	260	150	260	150	150	---
Nitrogen Dioxide	Annually	100	---	---	---	---	100	---	100	---	100	---
Non-Methane Hydrocarbons[d]	3-Hour (0600-0900)	160	---	---	---	---	---	---	---	---	160	---
Ozone	1-Hour	240	---	---	---	---	240	---	240	---	160	---
Carbon Monoxide	8-Hour	10,000	---	---	---	---	10,000	---	10,000	---	10,000	---
	1-Hour	40,000	---	---	---	---	40,000	---	40,000	---	40,000	---
Lead	Quarterly	1.5	---	---	---	---	---	---	---	---	---	---

Source: Dietrich, et al. 1983.

[a] Short-term standards (those other than annual and quarterly) are not be be exceeded more than once each year.

[b] Ambient standards are the absolute maximum levels allowed to protect either public health (primary) or welfare (secondary).

[c] Prevention of Significant Deterioriation (PSD) standards are the maximum incremental increase levels allowed above the baseline amounts of pollutants in regions of clean air.

[d] The Non-Methane Hydrocarbon standard was established as a guide in evaluating attainment of the ozone standard.

- Summarizing analyses and determining the potential for violation or consumption of air quality standards and increments.

Prior to applying the models, the following assumptions/conditions were established.

- Two development years (1990 and 2000), two levels (low and high) at each year, and three combinations of source effects (all sources, new federal leasing only, and all sources without new leasing) for each development level would be evaluated for worst-case air quality impacts.
- 24-hour average Prevention of Significant Deterioration (PSD) increments are the most restrictive (Latimer and Doyle 1981); therefore violations would be caused first under 24-hour, worst-case conditions.
- Only total suspended particulates (TSP), sulfur dioxide (SO_2), and nitrogen oxides (NO_x) criteria pollutants would be emitted in significant amounts.
- Based on monitoring results and basic modeling techniques (Turner 1969), input parameters would be selected to minimize atmospheric mixing, including: a west-southwest wind at 4 meters per second, an effective plume rise above ground level of 300 meters for elevated sources and 25 meters for low-level sources, Pasquill Class E stability, and a wet adiabatic lapse rate.
- A 4-minute latitude and longitude (5.9 km E-W by 7.4 km N-S) grid scale would be large enough to contain sensitive areas of concern and provide adequate resolution for evaluation of potential air quality effects from oil shale development.
- Emission rates for direct mining/surface retorting (assumed for Colorado Lease A, and the Utah and Wyoming federal leases) and mine assisted in situ (assumed for Colorado Federal Lease B) development processes would be proportional to "TOSCO II" and "C-b MIS" emission rates, respectively. Emissions would be controlled by the Best Available Control Technology (BACT).
- Scenarios and emission factors used for the draft Uintah Basin Synfuels EIS and the Prototype Oil Shale Leasing Program EIS would be incorporated into the Federal Oil Shale Management Program EIS. Emission estimates would be reviewed by appropriate regulatory authority.
- Thirty-four point and area sources were considered as major emitting facilities in the analyses. These sources included major oil shale, power plant, and synthetic fuel processing facilities whose pollutants are subject to long-range transport and are potentially the primary contributors to the degradation of air quality in sensitive areas

downwind of rates for modeled sources are shown in Table A-2-2. Table A-2-3 lists their emission totals and anticipated emissions from additional development under various scenarios.

Because of the general nature of the anticipated scenarios and the specific development details such as final source locations and mining and retort processes, production and emission rates are estimated. Actual development would require on-site meteorological data and site-specific engineering and emission information in order to conduct an air quality analysis required for PSD and other required permits.

The air quality modeling approach used for the Federal Oil Shale Management Program EIS was oriented to National Environmental Policy Act (NEPA) requirements and, by necessity, estimates worst-case impacts. Site-specific air quality analyses for a regulatory process such as PSD permitting may provide more accurate, realistic results. The Clean Air Act (Public Law 95-95) ensures through state and federal regulatory programs that a major emitting facility will not be constructed if it causes or contributes to ambient air quality standard violations. The PSD program also requires that in areas where standards are currently being met, no major emitting facility can be constructed if it causes Class II increments to be exceeded. In Class I areas, a waiver for exceeding an increment can be granted only if the manager of the area is convinced air quality related values (AQRV's) will not be adversely affected. Thus, the Clean Air Act guarantees that air quality will not deteriorate beyond standards. Detailed locations of Class II areas as identified in the analyses and tables are given in Table A-2-4.

The results of the air quality analyses must be evaluated with an understanding of the general limitations of air quality modeling in complex terrain - uncertainties of an order of magnitude (10') can be expected. The results are presented showing this range of reliability, with the higher number representing the worst-case conservative (highest) estimate and the lower number approximately an order of magnitude less. The potential for PSD Class I and Class II increment consumption is described throughout this EIS as high, moderate, or low, depending on the relationship between the predicted pollutant concentration range and the corresponding standard. The following convention was used: a high potential if the range was completely above the increment, moderate potential if the range was "centered" around the increment, and low potential if the high end of the range was somewhat above the increment. Ranges completely below the increment are considered as no potential and are not discussed.

SOCIOECONOMICS

Estimates of population and employment impacts under the no-action alternative were completed using existing models and projections. The Utah Process and Economic Demographic (UPED) model was used in making population and employment projections for Utah, given the assumptions of present development (including oil shale production) found in Appendix 4. Projections for the

TABLE A-2-2

PROJECT OPERATION ASSUMPTIONS FOR MODELED POINT SOURCES[a]

SOURCE	ELEVATION	LOCATION		PROOUCTION RATE		
		LATITUDE	LONGITUOE	1990 LOW	1990 HIGH/2000 LOW	2000 HIGH
Colorado Synfuel						
Cathedral 8luffs	2100m	39° 48'	108° 14'	0	21	76
Chevron-Retort	2470m	39° 19'	108° 25'	0	50	100
Chevron-Upgrade	1550m	39° 37'	108° 44'	0	50	100
Colony	2440m	39° 37'	108° 07'	48	48	48
Mobil	2560m	39° 32'	108° 05'	0	0	50
Prototype Tract C-11	2000m	39° 55'	108° 21'	0	0	25
Rio 8lanco	2230m	39° 53'	108° 32'	0	50	100
Superior-Pacific	1770m	39° 32'	108° 18'	0	0	15
Union	2320m	39° 24'	108° 05'	10	50	90
Colorado Federal Lease A	2320m	39° 52'	108° 30'	0	40	140
Colorado Federal Lease 8	2210m	39° 45'	108° 09'	0	40	140
Colorado Other						
Craig Power Plant	1920m	40° 28'	107° 35'	1340	1340	1340
Hayden Power Plant	1980m	40° 29'	107° 11'	465	465	465
Utah Synfuel						
Agency Oraw	1800m	39° 44'	109° 40'	0	11	20
C&A Tar Sands	2400m	39° 24'	109° 22'	20	20	20
Lofreco #1	1800m	39° 51'	109° 20'	0	6	15
Lofreco #2	2000m	39° 39'	109° 17'	0	6	15
Lofreco #3	1950m	39° 41'	109° 28'	0	8	20
Magic Circle	1580m	39° 56'	109° 36'	0	16	32
Paraho-Ute	1650m	40° 01'	109° 07'	10	10	42
P.R. Springs Tar Sands	2300m	39° 25'	109° 37'	50	50	50
Rainbow Tar Sands	2130m	39° 44'	109° 08'	5	5	5
Ramex	1500m	40° 02'	109° 21'	5	5	5
Sohio Tar Sands	1550m	40° 20'	109° 30'	15.6	15.6	15.6
Syntana	1770m	40° 03'	109° 05'	0	17	57
TOSCO Sand Wash	1520m	40° 00'	109° 32'	0	22	45
Western Tar Sands	1800m	40° 14'	109° 16'	5	5	5
White River	1650m	39° 56'	109° 11'	15	50	100
Utah Federal Lease	1660m	39° 54'	109° 38'	0	40	80
Utah Other						
Moonlake Power Plant	1520m	40° 05'	109° 16'	800	800	800
Plateau Refinery	1550m	40° 17'	110° 00'	---	---	---
Wyoming Synfuel						
Wyoming Federal Lease	2050m	42° 10'	110° 08'	0	0	40
Wyoming Other						
8ridger Power Plant	2020m	41° 44'	108° 47'	2000	2000	2000
Trona Mines (combined)	2020m	41° 48'	109° 28'	12	12	12
Synfuel Summary						
Colorado Synfuel				50	299	784
Utah Synfuel				126	287	527
Wyoming Synfuel				0	0	40
Total Synfuel				184	586	1351

---

[a] Synfuel production in 1000 barrels per day; power plant capacity in megawatts; trona mine production in million tons per year.

TABLE A-2-3

TOTAL EMISSION ASSUMPTIONS FOR MODELED POINT SOURCES (gm/sec)[a]

	1990 LOW			1990 LOW/2000 HIGH			2000 HIGH		
SOURCE	TSP	SO_2	NO_X	TSP	SO_2	NO_X	TSP	SO_2	NO_X
Colorado Synfuel									
Cathedral 8luffs	0	0	0	19	42	172	67	153	621
Chevron-Retort	0	0	0	77	51	516	154	101	1031
Chevron-Upgrade	0	0	0	8	22	92	16	44	183
Colony	34	40	220	34	40	220	34	40	220
Mobil	0	0	0	0	0	0	50	66	194
Prototype Tract C-11	0	0	0	0	0	0	22	50	204
Rio 8lanco	0	0	0	39	14	117	78	28	233
Superior-Pacific	0	0	0	0	0	0	10	44	22
Union	10	13	39	50	66	194	90	120	350
Colorado Federal Lease A	0	0	0	28	33	183	99	115	642
Colorado Federal Lease 8	0	0	0	35	81	327	123	282	1143
Colorado Other									
Craig Power Plant	90	371	742	90	371	742	90	371	742
Hayden Power Plant	23	348	245	23	348	245	23	348	245
Utah Synfuel									
Agency Oraw	0	0	0	7	41	34	13	75	62
C&A Tar Sands	14	11	12	14	11	12	14	11	12
Lofreco #1	0	0	0	4	51	17	9	127	43
Lofreco #2	0	0	0	4	51	17	9	127	43
Lofreco #3	0	0	0	5	68	23	13	170	58
Magic Circle	0	0	0	15	20	114	30	41	229
Paraho-Ute	6	12	32	6	12	32	27	50	134
P.R. Springs Tar Sands	28	31	61	28	31	61	28	31	61
Rainbow Tar Sands	4	3	3	4	3	3	4	3	3
Ramex	3	42	14	3	42	14	3	42	14
Sohio Tar Sands	140	81	71	140	81	71	140	81	71
Syntana	0	0	0	11	11	62	36	36	206
TOSCO Sand Wash	0	0	0	17	13	107	35	26	218
Western Tar Sands	6	3	3	6	3	3	6	3	3
White River	8	6	34	27	19	115	55	38	230
Utah Federal Lease	0	0	0	28	33	183	57	66	367
Utah Other									
Moonlake Power Plant	31	53	281	31	53	281	31	53	281
Plateau Refinery	14	9	136	14	9	136	14	9	136
Wyoming Synfuels									
Wyoming Federal Lease	0	0	0	0	0	0	28	33	183
Wyoming Other									
Bridger Power Plant	55	380	610	55	380	610	55	380	610
Trona Mines (combined)	203	110	111	203	110	111	203	110	111

---

[a] Synfuel production in 1000 barrels per day; power plant capacity in megawatts; trona mine production in million tons per year.

TABLE A-2-4

DETAILED LOCATIONS OF CLASS II AREAS

1. Buckskin Hills - Latitude 40° 28' Longitude 109° 24'
'admist' the Buckskin Hills
SE 1/4 NE 1/4 sec. T. 6 N. R. 22 E.
1 mile west of Brush Creek
6.5 miles east-northeast of Vernal
3.5 miles west of Dinosaur National Monument

2. Baxter Pass - Latitude 39° 36' Longitude 108° 56'
2.5 miles east of Colorado/Utah state line
2 miles west of Baxter Pass
10 miles northwest of Lookout Mountain
3 miles southwest of McAndrews Lake, Garfield County
44 miles northwest of Grand Junction
26 miles north-northwest of Mack
10 miles west of Douglas Pass

3. Cottonwood Creek - Latitude 39° 56' Longitude 108° 56'
6 miles north of Rabbit Mountain
13 miles southwest of Rangely
2.5 miles east of Colorado/Utah state line, Rio Blanco County
near Cottonwood Creek

4. Wolf Creek - Latitude 40° 24' Longitude 108° 36'
3 miles south of Dinosaur National Monument
10 miles of Masodoia, Moffat County
24 miles northeast of Rangely, near Wolf Creek
5 miles south of Yampa River
22 miles east of Colorado/Utah state line
9 miles west-northwest of Elk Springs (town)
3.5 miles northwest of "MF" Mountain, north of Highway 40

5. Big Duck Creek - Latitude 39° 56' Longitude 108° 28' on Big Duck Creek
8 miles east of Cathedral Bluffs (formation), in western Piceance Basin,
Rio Blanco County
18 miles southeast of Rangely

6. Big Mountain - Latitude 39° 40' Longitude 107° 52' in White River
National Forest on west slope of "Big Mountain", Garfield County,
Colorado
2 miles east of Grand Hogback
Near headwaters of West Miller Creek (1 mile west of)
19 miles north-northwest of Rifle
6 miles northeast of Rio Blanco
T. 3 S. R. 93 W.

7. East Miller Creek - Latitude 39° 48' Longitude 107° 44'
White River National Forest, on top of drainage divide for East Miller
Creek and East Rifle Creek
18.5 miles north of Rifle
12 miles east-northeast of Rio Blanco
T. 3 S. R. 92 W.

8. Fontenelle Reservoir - Latitude 42° 12' Longitude 110° 04'
Northeast corner of Lincoln County
12 miles southeast of Clara Bird's Nipple
9 miles north-northeast of Fontenelle
4 miles east of Fontenelle Reservoir
6 miles east Highway 189
Amidst the "Little Colorado Desert"
4 miles south of Steed Canyon

9. Jack Morrow Creek - Latitude 42° 04' Longitude 108° 56'
T. 24 N. R. 102 W.
2 miles west of Continental Divide (7,400 and Busle Rim)
1 miles northeast of Monument Ridge
10 miles east of Essex Mountain
27 east-southeast of Favson, in the Wind River Range

10. Whiskey Peak - Latitude 42° 20' Longitude 107° 36'
3 miles northeast of Whiskey Peak
5 miles southwest of Three Forks (town)
40 miles north-northwest of Rawlins
Headwaters of Muddy Creek, between Green Mountain and Ferris Mountain

Colorado portion of the no-action alternative were developed by using the existing Planning and Assessment Model (PAS) of the Colorado Interagency Task Force (CITF).

Wyoming projections were taken from a Mountain West Research Study (unpublished) completed for the Wyoming Department of Administration and Fiscal Control.

For the proposed action, the population and employment increases were calculated by applying the following assumptions to the assumed direct employment:

Multiplier for operating personnel equals 1.8.
Family size of operating personnel is 3.85.
Local direct hire is 10 percent.
Percentage married and single are 90 and 10 percent, respectively.
Indirect hire of family members of in-migrants is 80 percent.

SURFACE WATER

Changes in the water supply system and water quality (salinity) were estimated by using the Bureau of Reclamation's Colorado River Simulation System (CRSS). The CRSS is a computerized simulation model that contains all the "Laws of the River."* The model consists of 24 reaches, each of which represents a specific geographic area. In this study, six reaches were modified to represent potential water depletion due to future development of (1) other planned projects in the study area through 2010, and (2) potential federal leasing.

*Disclaimer: The Colorado River Simulation System that was used in preparing the water section of this EIS is not to be construed as reflecting the present or future position of the states of the upper or lower Colorado River Basin or of the federal government with regard to interpretation and application of the treaties, compacts, and laws which do or may affect the allocation of water among the states and among private claimants within each state. In particular, nothing in this EIS is intended to interpret the provisions of the Colorado River Compact (45 Stat. 1957), the Upper Colorado River Basin Compact (53 Stat. 31), the Water Treaty of 1944 with the United Mexican States (Treaty Series 994, 59 Stat. 1219), the decree entered by the Supreme Court of the United States in Arizona v. California (376 U.S. 340), the Boulder Canyon Project Adjustment Act (54 Stat. 774; 43 U.S.C. 618a), the Colorado River Storage Project Act (70 Stat. 105; 43 U.S.C. 620), or the Colorado River Basin Project Act (82 Stat. 885; 43 U.S.C. 1501), or to interpret or reach any conclusions regarding future application of the federal reserved rights doctrine. For a complete summary of the CRSS series, refer to the USDI, Bureau of Reclamation, Colorado River Simulation System-Executive Summary, October 1982.

METHODOLOGIES-SURFACE WATER

For purposes of this EIS, baseline conditions were determined by projecting past and present water depletions through 2010. Because of this, the baseline used in the model shows an increase through the study years (1983 to 2010). This baseline increase does not, however, include water required for oil shale development in the oil shale region or water associated with any of the other projects and uses shown in Appendix 4.

Several model runs were made to determine the impacts associated with the various levels of oil shale development, both on federal leases and on other lands, and the cumulative impacts (of the above oil shale development and water uses associated with other projects and uses).

The water use figures for oil shale development on federal leases assumed that 8,000 ac-ft/yr was needed for each 50,000 bbl/day of shale oil production. Water sources for the potential federal leases were assumed to be from large, reliable water sources as follows: Colorado lease, the Colorado River; Utah lease, the Green River; and Wyoming lease, the Green River. The water use figures and sources associated with other oil shale developments were used as submitted by the operators of these projects. In a similar fashion, water use and sources associated with other projects and uses were used as submitted by the operators.

From the water use and water source data, a water depletion schedule was set up, which is a compilation of water depletion data that shows by year and project how much water will be depleted from the rivers that were modeled: the Yampa, White, Duchesne, Green, and Colorado rivers. These water use figures, along with the baseline, served as the raw input data for the various computer runs.

Method of Analysis

Two types of analysis were used to predict impacts in this EIS: (1) a modeling effort specifically designed for analysis of the impacts due to federal leasing (proposed action, 2000, low level, and high level), (2) use of a previous model, from the Uintah Basin Synfuels Development EIS, to estimate the impacts associated with the remaining analysis points (no-action, low level 1990 and 2000, and high level 2000).

To determine impacts associated with each analysis point, water depletions and resulting flow and salinity were compared to baseline conditions. The incremental differences were then determined on individual rivers -- the Yampa, White, Duchesne, Upper and Lower Green, and the Colorado. These increments were then additively assessed at the inflow to Lake Powell and at Imperial Dam. Points where flow and salinity values were measured are shown on Figure A-2-1.

Data required to modify the Bureau of Reclamation's model is shown in Tables A-2-5 through A-2-7. Table A-2-5 shows projects that were added to the baseline to determine impacts and also shows the probable source of water, the amount of water, and the state the project is located in. Table A-2-6 shows the amount of water use that will occur at various measuring points (i.e., White River at mouth, inflow to Lake Powell, etc.) by year and by no-action or

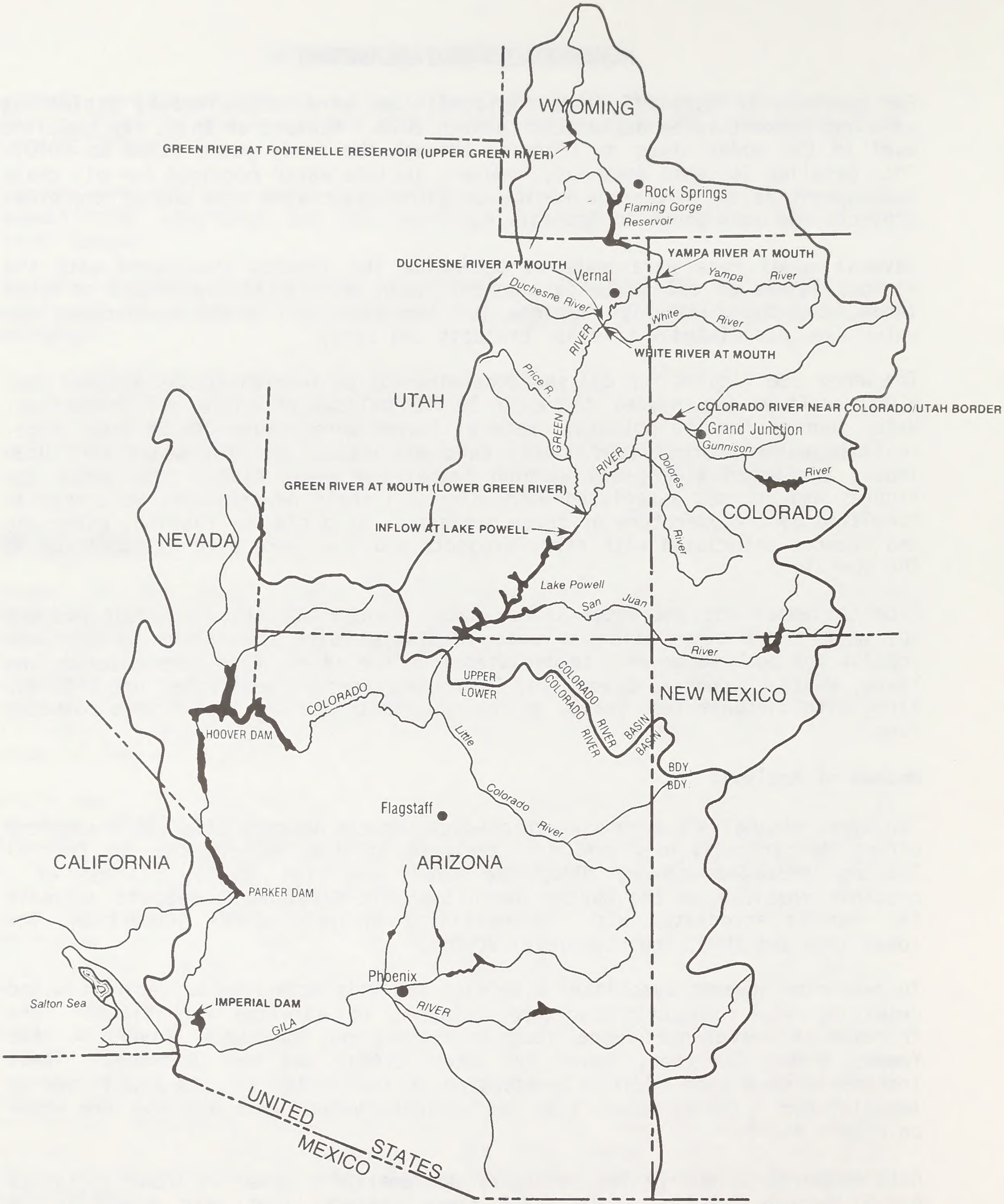


FIGURE A-2-1 MEASURING POINTS USED TO DETERMINE IMPACTS FOR THE COLORADO RIVER BASIN

Source: Colorado River Simulation System Executive Summary (USDI, BR 1981)

Table A-2-5

PROJECT WATER USE BY ALTERNATIVE AND ANALYSIS LEVEL (ac-ft/yr x 1000)

	No Action			Proposed Action	
Location (River)	1990 Low	2000 Low	2000 High	2000 Low	2000 High
COLORADO (near CO/UT border)					
1983	0	0	0	0	1
1985	0	6	11	8	16
1990	0	12	21	16	36
1995	0	17	30	23	68
2000	0	22	39	29	84
2005	0	22	39	29	84
2010	0	22	39	29	84
WHITE (at mouth)					
1983	0	0	2	0	2
1985	13	17	34	17	34
1990	30	40	71	40	71
1995	42	56	98	56	98
2000	60	80	141	80	141
2005	67	89	159	89	159
2010	67	89	159	89	159
DUCHESNE (at mouth)					
1983	0	0	0	0	0
1985	0	0	0	0	0
1990	0	0	2	0	2
1995	0	0	2	0	2
2000	0	0	12	0	12
2005	0	0	12	0	12
2010	0	0	12	0	12
GREEN (from Fontenelle Reservoir to mouth)					
1983	0	0	0	0	0
1985	10	13	22	17	23
1990	20	26	47	35	50
1995	20	26	47	35	52
2000	20	26	47	35	60
2005	20	26	47	35	60
2010	20	26	47	35	60
YAMPA (at mouth)					
1983	0	0	0	0	0
1985	0	0	0	0	0
1990	0	0	2	0	2
1995	0	0	4	0	4
2000	0	0	16	0	16
2005	0	0	16	0	16
2010	0	0	16	0	16
GREEN (from source to Fontenelle Reservoir)					
1983	0	0	14	11	14
1985	0	0	16	12	16
1990	0	0	45	20	45
1995	0	0	49	20	52
2000	0	0	49	20	55
2005	0	0	49	20	55
2010	0	0	49	20	55
Collective Water use above inflow to Lake Powell					
1983	0	0	16	11	17
1985	23	36	83	54	89
1990	50	78	188	111	206
1995	62	99	230	134	276
2000	80	128	304	164	368
2005	87	137	322	173	386
2010	87	137	322	173	386

Table A-2-6

PREDICTED WATER DEPLETIONS
(ac-ft/yr x 1000)

		No Action			Proposed Action	
Location (River)	Baseline	1990 Low	2000 Low	2000 High	2000 Low	2000 High
COLORADO (near CO/UT border)						
1983	785	785	785	785	785	786
1985	801	801	807	812	809	817
1990	891	891	903	912	902	927
1995	960	960	977	990	975	1028
2000	1040	1041	1063	1080	1070	1125
2005	1069	1069	1091	1108	1098	1153
2010	1097	1097	1119	1136	1126	1181
WHITE (at mouth)						
1983	37	37	37	39	Same as no action 2000 low	Same as no action 2000 high
1985	37	49	54	71		
1990	147	177	187	218		
1995	147	189	203	245		
2000	166	226	246	307		
2005	166	233	255	325		
2010	166	233	255	325		
DUCHESNE (at mouth)						
1983	466	466	466	466	Same as no action 2000 low	Same as no action 2000 high
1985	499	499	499	499		
1990	625	625	625	627		
1995	649	649	649	651		
2000	666	666	666	678		
2005	666	666	666	678		
2010	666	666	666	678		
GREEN (from Fontenelle Reservoir to mouth)						
1983	120	120	120	120	120	120
1985	120	130	133	142	137	143
1990	120	140	146	167	155	170
1995	150	170	176	197	185	202
2000	150	170	176	197	185	210
2005	150	170	176	197	185	210
2010	150	170	176	197	185	210
YAMPA (at mouth)						
1983	87	87	87	87	Same as no action 2000 low	Same as no action 2000 high
1985	87	87	87	87		
1990	108	108	108	110		
1995	108	108	108	112		
2000	144	144	144	160		
2005	144	144	144	160		
2010	174	174	174	190		
GREEN (from source to Fonetnelle Reservoir)						
1983	227	227	241	241	238	241
1985	229	229	245	245	241	245
1990	244	244	299	299	264	299
1995	257	257	306	306	277	309
2000	288	288	337	337	302	343
2005	313	313	362	362	333	368
2010	338	338	387	387	358	393

Table A-2-7

PREDICTED FLOWS (ac-ft/yr x 1000)

		No Action			Proposed Action	
Location (River)	Baseline	1990 Low	2000 Low	2000 High	2000 Low	2000 High
COLORADO (near CO/UT border)						
1983	7584	7584	7584	7584	7584	7583
1985	2461	2461	2455	2450	2453	2445
1990	2995	2995	2983	2974	2979	2959
1995	2623	2623	2606	2593	2600	2555
2000	4591	4591	4569	4552	4562	4507
2005	4065	4065	4043	4026	4036	3981
2010	4473	4473	4451	4434	4444	4389
GREEN (at confluence with Colorado)						
1983	6540	6530	6527	6504	6529	6526
1985	2341	2321	2315	2278	2326	2302
1990	2287	2267	2261	2195	2258	2192
1995	4283	4263	4257	4187	4254	4179
2000	3978	3958	3952	3882	3949	3873
2005	4225	4205	4199	4129	4196	4120
2010	3856	3836	3830	3760	3827	3751
WHITE (at confluence with Green)						
1983	693	693	693	691	Same as no action 2000 low	Same as no action 2000 high
1985	352	339	335	318		
1990	296	266	256	225		
1995	294	252	238	196		
2000	355	295	275	214		
2005	376	309	287	217		
2010	381	314	292	222		
YAMPA (at mouth)						
1983	2223	2223	2223	2223	Same as no action 2000 low	Same as no action 2000 high
1985	782	782	782	782		
1990	1048	1048	1048	1046		
1995	1129	1129	1129	1127		
2000	1564	1564	1564	1552		
2005	1861	1861	1861	1849		
2010	1457	1457	1457	1445		
DUCHESNE (at mouth)						
1983	956	956	956	956	Same as no action 2000 low	Same as no action 2000 high
1985	116	116	116	116		
1990	56	56	56	54		
1995	121	121	121	117		
2000	382	382	382	366		
2005	91	91	91	75		
2010	279	279	279	263		
Inflow to Lake Powel						
1983	16817	16817	16817	16801	16806	16800
1985	5898	5875	5862	5815	5844	5809
1990	6444	6394	6366	6256	6333	6238
1995	7759	7697	7660	7529	7625	7483
2000	10248	10168	10120	9944	10084	9880
2005	9213	9126	9076	8891	9040	8827
2010	10075	9988	9938	9753	9902	9689

proposed action analysis point. Table A-2-6 shows the changes in depletions based upon predicted future flows and the water use figures associated with the projects in Table A-2-7; similarly, Figure A-2-2 graphically shows the baseline vs. worst case depletions.

Table A-2-8 shows the output for the model - the changes in flow and the changes in salinity. These values are shown for all analysis points and are graphically shown in Figures A-2-3, A-2-4, and A-2-5.

VISUAL RESOURCES

To analyze the landscape in which the proposed action would occur, the Bureau of Land Management's (BLM) Visual Resource Management (VRM) system and the Forest Service's (FS) Visual Management System (VMS) were used.

To compare the visual impacts of the proposed program, the VRM system was applied to lands managed by the BLM, as well as other federal lands (other than national forest lands for which the VMS procedure was applicable), and state, local, Indian, and private lands.

The following three sections describe the VRM system, the VMS, and the BLM contrast rating procedure.

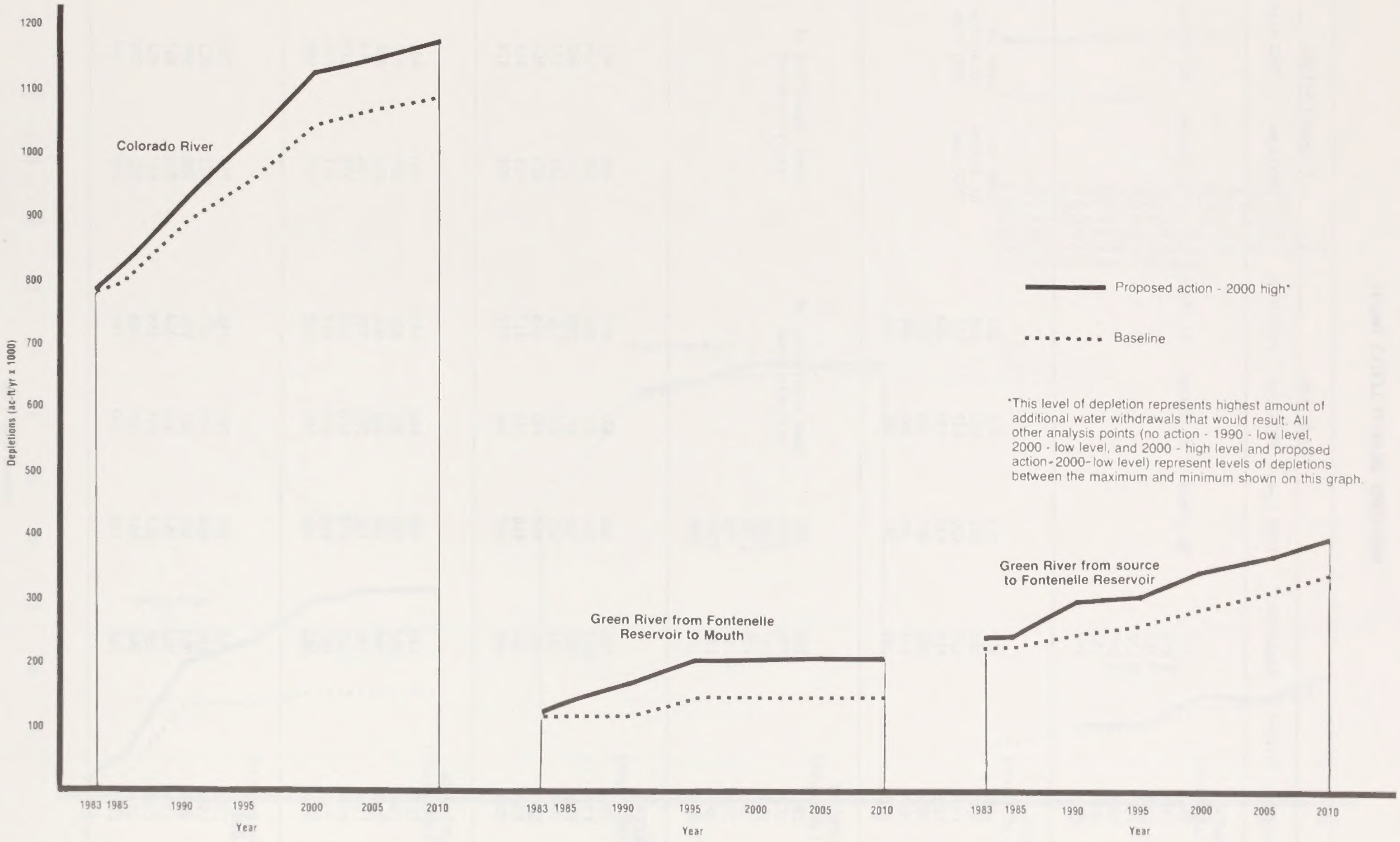
The BLM Visual Resource Management System

The VRM system is an analytical process that identifies, sets, and meets objectives for maintaining scenic values and visual quality (BLM 1978b, 1980f).

The system is based on research that has produced ways of assessing aesthetic qualities of the landscape in objective terms. Aesthetic judgments considered extremely subjective were found to have identifiable, consistent qualities that can be described and measured. Whatever the terrain and whoever the observer, perception of visual quality in a landscape seems to be based on three common principles:

- Landscape character
- Influence of form, line, color, and texture
- Visual variety

Landscape character is primarily determined by the four basic visual elements of form, line, color, and texture. Although all four elements are present in every landscape, they exert varying degrees of influence. The stronger the influence exerted by these elements, the more interesting the landscape. The more visual variety in a landscape, the more aesthetically pleasing the landscape. However, variety without harmony is unattractive, particularly if alterations (cultural modifications) are made carelessly.



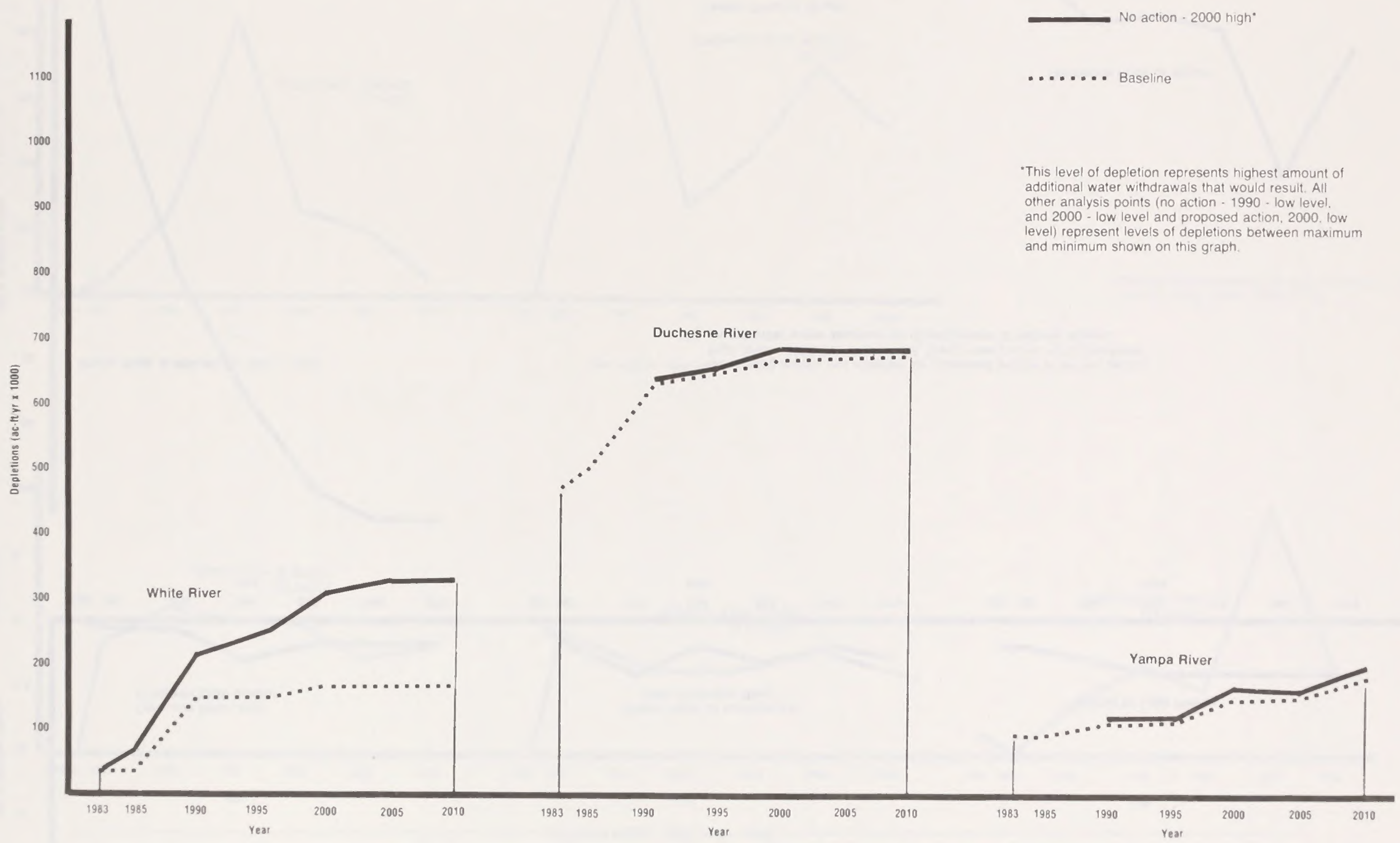
*This level of depletion represents highest amount of additional water withdrawals that would result. All other analysis points (no action - 1990 - low level, 2000 - low level, and 2000 - high level and proposed action-2000-low level) represent levels of depletions between the maximum and minimum shown on this graph.

FIGURE A-2-2 BASELINE AND FUTURE WATER DEPLETIONS ON RIVERS THAT ARE POTENTIAL SOURCES OF WATER FOR FEDERAL LEASING (1983-2010)

Table A-2-8

PREDICTED SALINITY LEVELS (mg/l)

		No Action			Proposed Action	
Location (River)	Baseline	1990 Low	2000 Low	2000 High	2000 Low	2000 High
YAMPA (at mouth)						
1983	127	No Change	No Change	No Change	No Change	No Change
1985	220					
1990	187					
1995	172					
2000	160					
2005	142					
2010	170					
WHITE (at mouth)						
1983	312	312	312	312	Same as no action 2000 low	Same as no action 2000 high
1985	522	522	523	524		
1990	424	430	432	437		
1995	415	433	439	458		
2000	399	407	409	412		
2005	377	383	385	387		
2010	393	393	395	396		
DUCHESNE (at mouth)						
1983	392	392	Same regardless of analysis point		Same regardless of analysis point	
1985	1938	1954				
1990	3337	3386				
1995	1745	1758				
2000	734	756				
2005	2134	2369				
2010	868	894				
GREEN (at mouth)						
1983	402	402	402	403	402	403
1985	617	624	627	634	630	634
1990	560	568	571	580	575	582
1995	513	521	524	532	527	533
2000	446	454	457	465	459	465
2005	404	410	412	417	414	419
2010	458	464	466	472	469	474
Inflow to Lake Powell						
1983	440	440	440	441	440	441
1985	893	900	903	910	906	911
1990	794	799	801	806	803	808
1995	746	750	752	755	754	758
2000	565	573	576	579	576	579
2005	602	608	610	614	611	618
2010	583	588	590	592	590	596
At Imperial Dam						
1983	755	755	756	758	757	758
1985	820	820	820	821	821	821
1990	983	986	987	991	989	999
1995	953	957	959	964	961	967
2000	952	954	955	959	957	962
2005	891	897	899	906	902	929
2010	756	759	760	765	762	768



*This level of depletion represents highest amount of additional water withdrawals that would result. All other analysis points (no action - 1990 - low level, and 2000 - low level and proposed action, 2000, low level) represent levels of depletions between maximum and minimum shown on this graph.

FIGURE A-2-3 BASELINE AND FUTURE WATER DEPLETIONS ON RIVERS THAT ARE NOT CONSIDERED AS POTENTIAL WATER SOURCES FOR FEDERAL LEASING

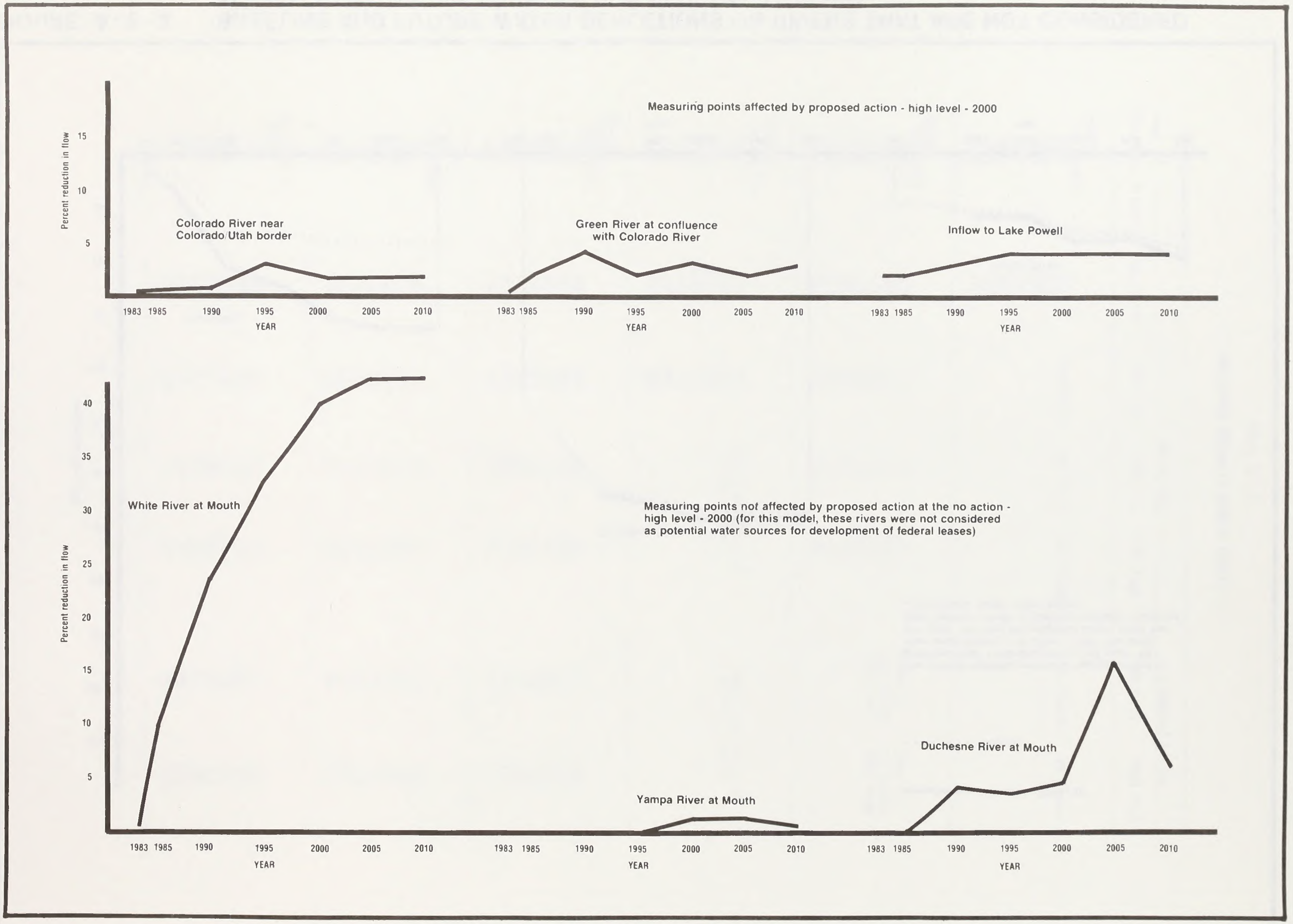


FIGURE A-2-4 PERCENT REDUCTION IN FLOW (1983-2010)

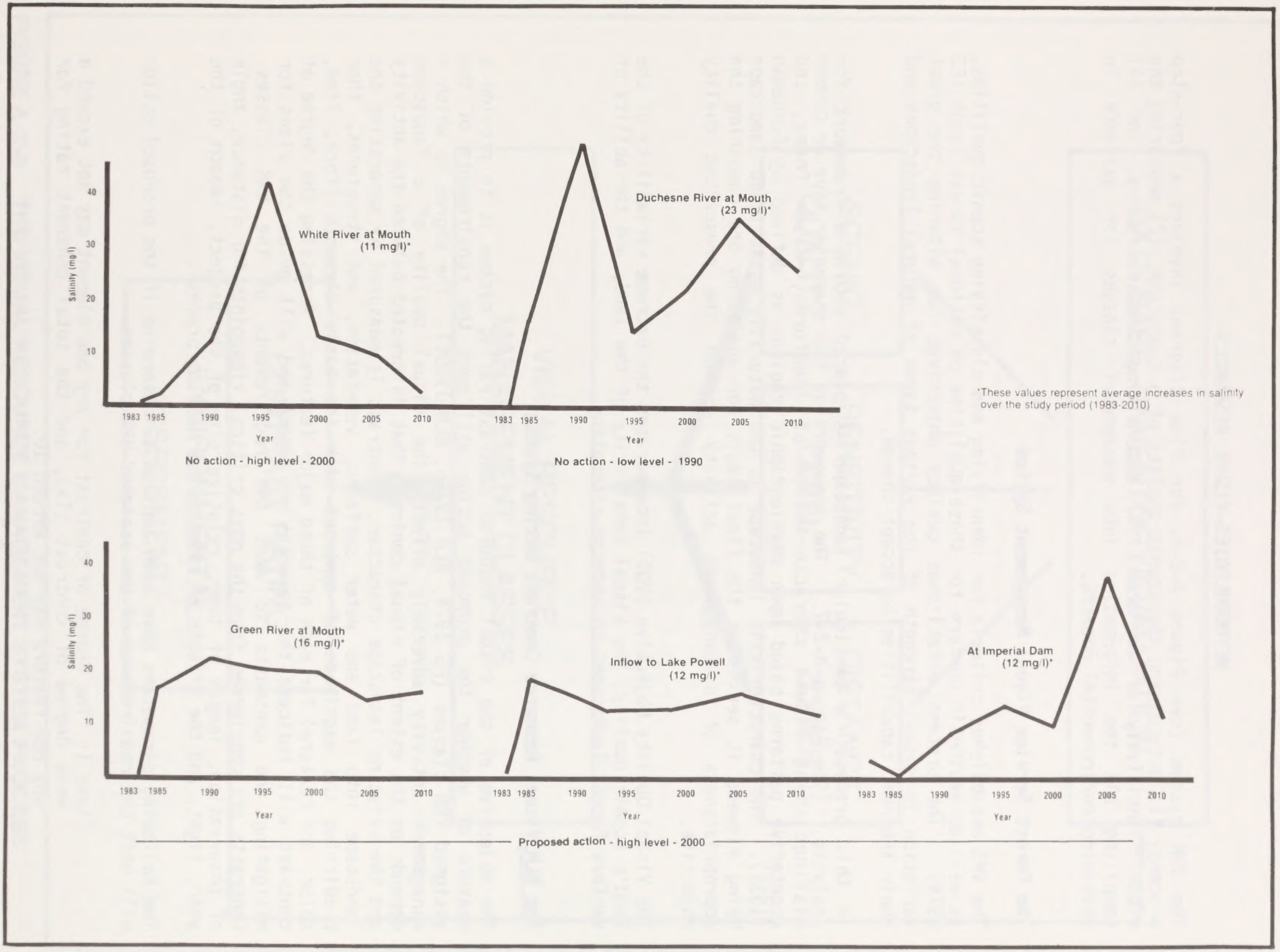


FIGURE A-2-5 CHANGES IN SALINITY (1983-2010)

The VRM system (see Figure A-2-6, for flow diagram) involves a four-step process: (1) determining the scenic quality of a landscape, (2) measuring the visual sensitivity of an area, (3) determining distance zones, and (4) compiling all the information into management classes for guidance in assessing environmental impacts.

The Forest Service Visual Management System

The VMS establishes criteria for identifying and classifying scenic qualities, as well as aesthetic concern for those qualities on national forest lands (FS 1974). The process establishes quality objectives for altering the great variation in visual strength of the various types of natural landscapes and their inherent capabilities to accept change.

In this process, a particular landscape is placed within a framework for analysis. (See Figure A-2-7.) The framework is the character type or common distinguishing visual characteristics of landforms, water forms, and vegetative patterns based upon physiographic regions as defined by Fenneman (1931). The characteristic landscape is the naturally established landscape being viewed; it serves as the final basis for analyzing and comparing the appropriateness of a management activity against the prescribed quality objective.

The Visual Quality Objective (VQO) incorporates the extreme variability of the land's scenic quality, the visual sensitivity of the land, and the ability of various forest landscapes to undergo alteration.

The BLM Visual Resource Contrast Rating System

The objective of the visual resource contrast rating system is to provide a measure of whether the proposed action will meet the requirements of the assigned VRM classes (FS 1974, BLM 1978b, BLM 1980f). The degree to which a management activity adversely affects the visual quality of a landscape depends on the extent of visual contrast that is created between the activity and the existing landscape character. Contrast is measured by separating the landscape into land and water surfaces, vegetation, and structures, then predicting the magnitude of contrast with the basic elements (form, line, color, and texture) for each of these major features. Assessing the degree of contrast will indicate the severity of impact and will guide the plans for mitigating the contrasts to meet the requirements of the VRM classes. Contrasts are considered from the most critical viewpoints for distance, angle of observation, length of time, relative size of the project, season of the year, light, and the effects of time on the healing process.

The following parameters have been applied to determine if the proposed action will meet the requirements of the assigned VRM classes.

Class I: The degree of contrast for any one element may not exceed a weak degree of contrast (1x), and the total contrast rating for any one feature may not exceed 10.

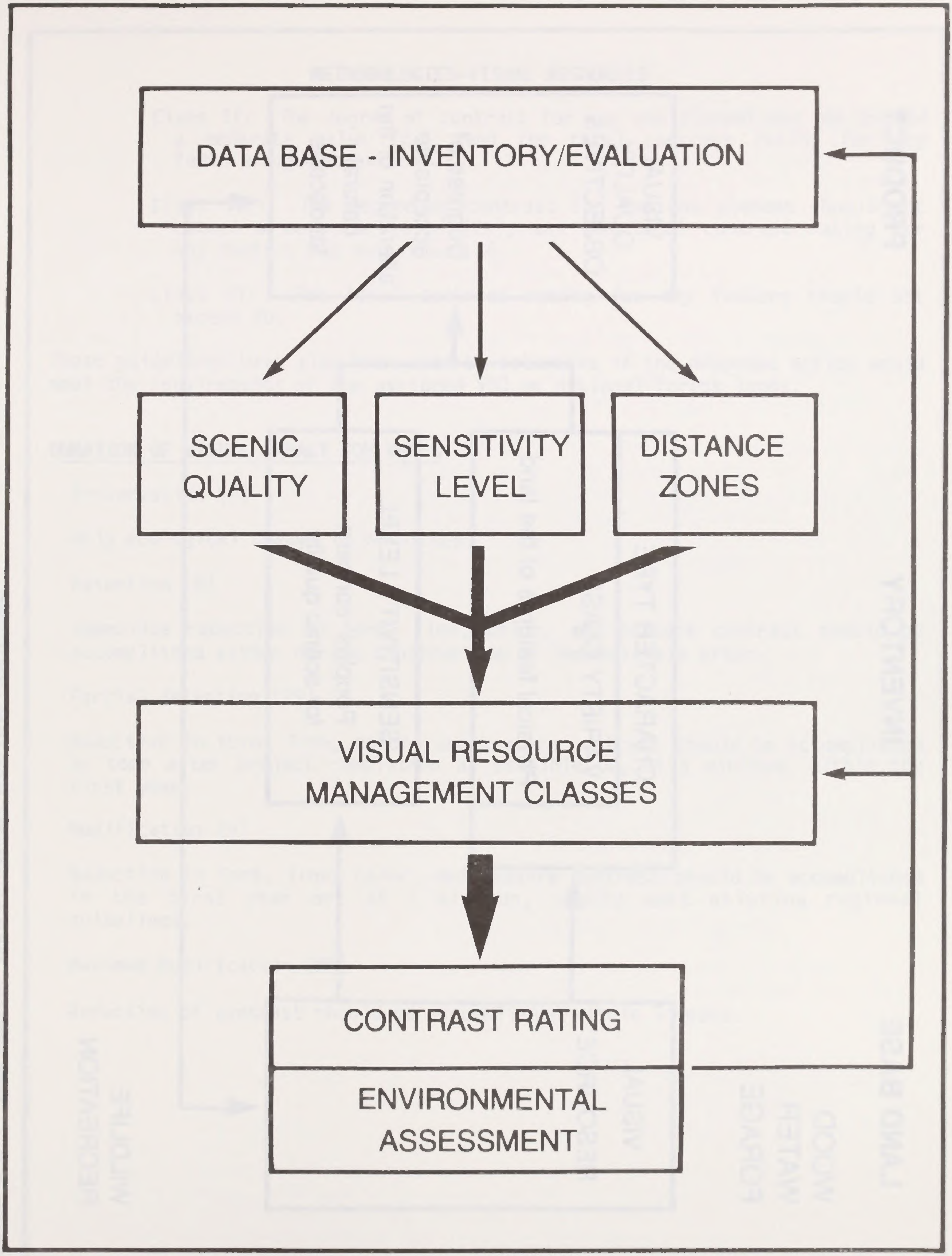


FIGURE A-2-6 THE VISUAL RESOURCE MANAGEMENT SYSTEM PROCESS

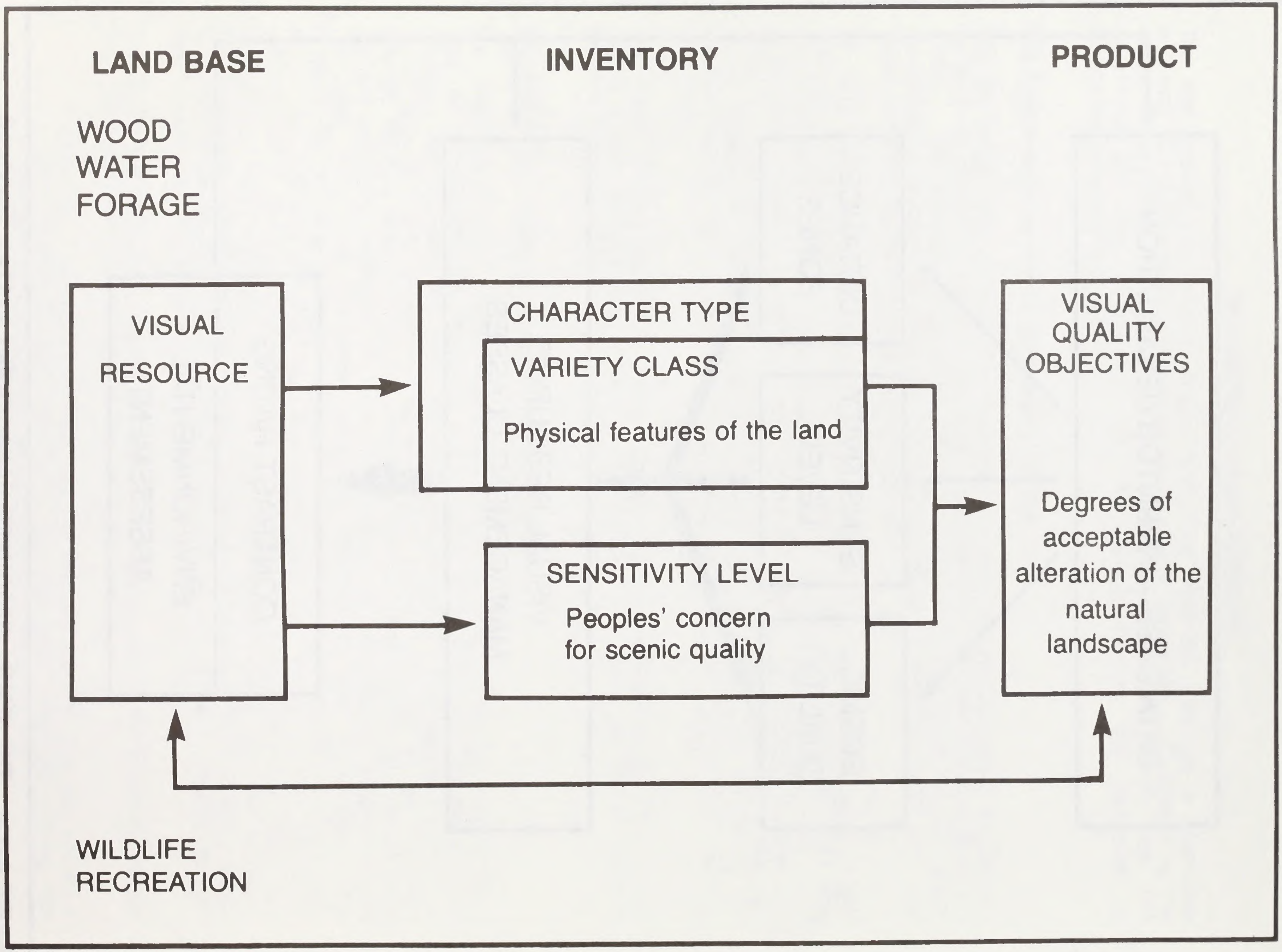

LAND BASE
INVENTORY
PRODUCT
WOOD
WATER
FORAGE
VISUAL
RESOURCE
CHARACTER TYPE
VARIETY CLASS
Physical features of the land
SENSITIVITY LEVEL
Peoples' concern for scenic quality
VISUAL QUALITY OBJECTIVES
Degrees of acceptable alteration of the natural landscape
WILDLIFE
RECREATION

FIGURE A-2-7 THE VISUAL MANAGEMENT SYSTEM PROCESS

Class II: The degree of contrast for any one element may not exceed a moderate value (2x), and the total contrast rating for any feature may not exceed 12.

Class III: The degree of contrast for any one element should not exceed a moderate value (2x), and the total contrast rating for any feature may not exceed 16.

Class IV: The total contrast rating for any feature should not exceed 20.

These guidelines have also been used to determine if the proposed action would meet the requirements of the assigned VQO on national forest lands.

DURATION OF VISUAL IMPACT FOR VQO'S

Preservation (P)

Only ecological change is permitted.

Retention (R)

Immediate reduction in form, line, color, and texture contrast should be accomplished either during construction or immediately after.

Partial Retention (PR)

Reduction in form, line, color, and texture contrast should be accomplished as soon after project completion as possible or, at a minimum, within the first year.

Modification (M)

Reduction in form, line, color, and texture contrast should be accomplished in the first year or, at a minimun, should meet existing regional guidelines.

Maximum Modification (MM)

Reduction of contrast should be accomplished within 5 years.

METHODOLOGIES-VISUAL RESOURCES

DEGREE OF CONTRAST

For purposes of this EIS, the contrasts for each VQO should not exceed the parameters established for the following comparable VRM Classes:

FS VQO's	BLM VRM CLASSES
Preservation (P)	Class I
Retention (R)	Class II
Partial Retention (PR)	Class III
Modification (M) and Maximum Modification (MM)	Class IV
Unacceptable Modification (UM)	Class V

Specific contrasts in form, line, color, and texture indicate problems that could require design mitigation. Applying design procedures to the proposed action could eliminate or reduce visual contrasts to meet the visual planning objectives stipulated in the VRM class designations. If this were done, the project would be reassessed to determine if it could meet the area's visual goals and, if not, to what degree the landscape's visual resource would be affected.

APPENDIX 3

HISTORY OF OIL SHALE DEVELOPMENT

1800's	Oil shale used by settlers in the Appalachians for lamp oil, lubricants, and for medicinal purposes.
1850	Oil shale plant operated on Ohio River, producing 30 gal/day.
1855	Mormons constructed a retort and recovered shale oil near Moab, Utah.
1859	Oil discovered in Titusville, Pennsylvania, and replaces oil shale as primary fuel source.
1890	Parachute Mining District founded to encourage development of oil shale in Colorado. Largest mining district in Colorado covering 15 square miles.
1890-1900	T.E. Bailey; experimental retort built on West Fork of Parachute Creek using the Scottish retort process.
1910	Use of internal combustion engine increases demand for oil; petroleum reserves appear to be diminishing; interest in oil shale revives.
1915	Dean L. Winchester, USGS geologist, surveyed Green River Formation and estimated 20 billion bbl of oil shale in the area. His calculations were believed to be too large.
1916	Dean L. Winchester returned to Green River Formation to resurvey the area. He agreed his calculations were in error and that they should have been 40 billion bbl of reserves. Subsequent publication of Oil Shale in Northwestern Colorado and Adjacent Areas spurs interest in oil shale.
1915-1930	As many as 200 oil shale corporations formed.
1915	First oil shale company, the Colorado Carbon Company.
1917	Oil Shale Mining Company builds the first commerical retort on Dry Fork, northwest of DeBeque. Retort unworkable due to caking of rock.
1920	Mineral Lands Leasing Act of 1920 closes oil shale lands for claim and ends land grab in the Green River Formation. By 1920, 30,000 claims had been staked in the State of Colorado and another 120,000 were staked in Utah and Wyoming.
1919-1922	Campbell Refining Co. collected $3 million on stocks at $10 per share. Claimed to produce 100 bbl of crude oil per day from shale yielding 60 gallons of shale oil per ton. Evidence in History of Western Oil Shale by Paul Russell proves no oil was produced and no retorts were built.

HISTORY OF OIL SHALE DEVELOPMENT

1920-1924	Catlin Shale Products of Elko, Nevada, processed 250 tpd of shale to produce 50 bpd of shale oil. Total production: 12,000 bbl of retorted shale oil.
1923	Discovery of oil reserves in California, Oklahoma, and Nevada helps put an end to oil shale boom.
1926-1929	Rulison, Colorado, produces 3,600 bbl of retorted oil shale.
1930	Oil discovered in Texas.
1930	Executive Order #5327 withdraws all federal oil shale lands from leasing for the purpose of examination and classification.
1944	Oil supply problems revive interest in oil shale; Synthetic Liquid Fuels Act provides money to build experimental oil shale station at Anvil Points, Colorado.
1950	Union Oil, Parachute Creek, Colorado; 50 tpd pilot retort.
1952	Executive Order 10355 issued by President Truman grants Secretary of the Interior the authority to reopen federal oil shale lands for leasing.
1954-1958	Sinclair Oil, Haystack Mountain, in western Colorado field tests in situ recovery.
1961	Union Oil Co. processes 15,000 bbl of raw shale oil into fuel at Fruita, Colorado.
1961-1968	Mobil Oil and Equity Oil experiment on in situ retorting on their properties; 350 tpd.
1964-1968	Colorado School of Mines Research Foundation and six oil companies test retort process at Anvil Points, Colorado.
1968	U.S. Department of the Interior: Offer of shale leases, no bidders.
1967-1974	Colony Development Company, Parachute Creek, western Colorado; 1,000 tpd, 700 bpd, Tosco II semi-works retort.
1969*	Federal Prototype Leasing Program initiated.
1972	Occidental Petroleum Corporation tests 30 bpd production on in situ recovery method.
1972-1974	Occidental Oil Shale Inc. experiments with three small, modified in situ retorts and produces 1200-1600 bbl with each retort.
1973-1974	Arab oil embargo and increase in OPEC oil prices stimulate interest in alternative energy resources.

HISTORY OF OIL SHALE DEVELOPMENT

1974*	Federal Prototype Lease sale. Tract C-a-Standard Oil of Indiana and Gulf Oil Corporation, Colorado. Tract C-b-Atlantic Richfield, Ashland Oil, Shell Oil, The Shell Oil Corporation, Colorado. Tract U-a-Sun Oil Company, Phillips Petroleum, Utah. Tract U-b-White River Shale Oil Corporation, Utah.
1974	Geokinetic's small-scale retort tests in steel chambers.
1974	Paraho Development Corporation experiments at Anvil Points facility and increases production to 35 bpd.
1975-1976*	Occidental Oil Shale Inc. produces 27,500 bbl of shale oil with rubblized and burned commercial size MIS retort.
1976-1978*	Occidental Oil Shale Inc. produces 66,287 bbl shale oil with rubblized and burn method in cooperation with Department of Energy.
1976-1978	Superior Oil Co. operates 250 tpd pilot retort producing 4,800 lbs/day soda ash plant and 75 tpd nahcolite separation unit.
1976*	Lease suspensions requested for prototype tracts C-a, C-b, U-a, and U-b.
1977-1979	Paraho-Ute Project retorts and refines 100,000 bbl of shale oil for Department of Defense.
1977	Geokinetics produces 1,700 bbl shale oil.
1980*	Equity/Department of Energy begin drilling and construction on site for true in situ.
1979-1982	Occidental Oil Shale/DOE begins preparation and operation for a 2,500 bpd demonstration plant.
1980-1981	Equity/DOE high pressure heater treater used for T2-20 bbl/day recovery.
1980	Paraho-Ute/DOE begins design for 18,000 tons per day, 11,000 bpd retort model.
1980	Geokinetics ignites experimental true in situ #23.
1980-1981*	Rio Blanco modified in situ retort rubblized and burned demonstration project. Currently working on engineering design and feasibility for open pit development.
1981*	Union Oil, Long Ridge Project. DOE grants a purchase price support to begin in 1983 for 10 years at up to 3.3 bbl/yr for Department of Defense.

HISTORY OF OIL SHALE DEVELOPMENT

1981	Tosco, Colony development awarded $1.1 billion loan guarantee from DOE under ESA/DPA in return for 10,000 bpd for military fuels.
1981*	White River Shale Corporation, Tracts U-a and U-b, submits updated Detailed Development Plan.
1982*	Cathedral Bluffs, Tract C-b, to finish re-engineering of its project.
1982*	White River Shale Corporation, Tracts U-a and U-b, begins construction of a three-phase project on each of its tracts.

*Significant data for prototype tracts.

Sources:

1. Athearn, P.J. 1981. The Parachute Colorado Mining District, 1980-1835 (unpublished manuscript), USDI, Bureau of Land Management.
2. Russell, Paul. 1981. An Oil Shale Perspective, Mining Engineer, V. 33, No. 1, pp. 32-38.
3. Russell, Paul L. 1980. History of Western Oil shales, Center for Professional Advancement, East Brunswick, N.J.
4. Russell, Paul L. 1976. Oil Shale Research: A Brief History, Colorado School of Mines Quarterly, V. 71, No. 4, pp. 173-176.

APPENDIX 4

PROJECT DATA USED IN DEVELOPING NO-ACTION ALTERNATIVE AND PROPOSED ACTION ANALYSES

This appendix contains the data for the projects used in each of the analysis combinations (see Figure 3-1) contained in Chapter 3. These combinations are:

- No-Action Alternative - Low Level - 1990 and 2000
- No-Action Alternative - High Level - 2000
- Proposed Action - Low Level - 2000
- Proposed Action - High Level - 2000

The appendix is separated into two major sections: 1. No-action alternative data, and 2. proposed action data. The data reflected in the tables is for operational conditions only. The tables were compiled using actual figures and estimates based on information received from individual project representatives, Colorado Department of Health, Colorado Division of Mines, Wyoming Department of Environmental Quality, Office of Surface Mines, BLM, Minerals Management Service, and the Environmental Protection Agency.

The oil shale projects and levels of production for the no-action alternative, low level 2000, and high level 1990 are based on the following data sources: 1. Colorado projects are based on Scenario I, developed by the Colorado Department of Health's Cumulative Environmental Impact Study (December 1981), with the assistance of the Rocky Mountain Oil and Gas Association. This scenario was adjusted to include the two prototype leases (C-a and C-b) from Scenario II. 2. Utah projects are based on the low level scenario from the Uintah Basin Synfuels Development EIS (BLM 1982g) obtained from oil shale companies.

The oil shale projects and level of production for the no-action alternative, high level 2000 are based on the following data sources: 1. Colorado projects are based on Scenario II developed by the Colorado Department of Health's Cumulative Environmental Impact Study (December 1981) with the assistance of the Rocky Mountain Oil and Gas Association, with adjustments in estimated production for the two prototype leases (C-a and C-b), based on Cameron Synthetic Fuel Report, December 1981. 2. Utah projects are based on the high level scenario from the Uintah Basin Synfuels Development EIS (BLM 1982g) obtained from oil shale companies.

TABLE A-4-1

NO ACTION ALTERNATIVE, LOW LEVEL PRODUCTION
(1990)

Project	Project Type	County (unless otherwise noted)	Production	Workforce (Peak)	Acres Disturbed
		Colorado Non-Oil Shale Projects			
Apex 2	Coal mine	Routt	0.02 mty	12	5
Bear	Coal mine	Gunnison	0.25 mty	70	8
Blue Ribbon	Coal mine	Delta	0.18 mty	58	11
Cameo 1 and 2	Coal mine	Mesa	1.6 mty	400	230
Colorado/Wyoming W.R. Grace	Coal mine	Moffat	4.085 mty	382	860
Craig	Coal fired power plant	Moffat	720 mty	300	1,500
Deserado	Coal mine	Rio Blanco	2.4 mty	594	700
Dorchester Fruita 1 and 2	Coal mine	Mesa	4.0 mty	590	195
Edna	Coal mine	Rio Blanco	0.18 mty	16	130
Empire Energy Eagle 5 and 9	Coal mine	Moffat	3.91 mty	512	920
Gary Energy	Oil refinery	Mesa	Expansion of 13,000 bpd to handle oil shale	200	200
Hawks Nest	Coal mine	Gunnison	0.72 mty	285	115
Hayden Gulch	Coal mine	Routt	0.75 mty	86	Leased in 1982 undeveloped
Meadow 1	Coal mine	Routt	1.01 mty	125	100
Meeker Area Complex Northern 1,2, and 3 Rainbow 2	Coal mine	Rio Blanco	4.25 mty	672	135
Mt. Gunnison	Coal mine	Gunnison	0.27 mty	70	8
Orchard Valley	Coal mine	Delta	1.1 mty	225	145
Red Canyon	Coal mine	Delta	0.151 mty	33	17
Salt Creek Mining Co.	Coal mine	Garfield	5.0 mty	900	676
Seneca	Coal mine	Routt	1.4 mty	89	970
Somerset	Coal mine	Delta	0.9 mty	232	39
Southwest	Coal-fired power plant	Mesa	500 Mw	235	1,400
Sunlight	Coal mine	Garfield	0.01 mty	6	5
Tomahawk	Coal mine	Delta	0.13 mty	28	105
Utah International	Coal mine	Moffat	2.88 mty	175	1,500
SUBTOTAL				6,385	9,974

TABLE A-4-1 (Continued)

NO ACTION ALTERNATIVE, LOW LEVEL PRODUCTION
(1990)

Project	Project Type	County (unless otherwise noted)	Production	Workforce (Peak)	Acres Disturbed
Colorado Oil Shale Projects					
Colony	Oil Shale	15 miles north of Grand Valley	48,000 bpd	2,050	3,500
Union	Oil Shale	15 miles north of Grand Valley	10,000 bpd	700	570
SUBTOTAL				2,750	4,070
Utah Non-Oil Shale Projects					
Baker Associates Inc.	Humate mining	Grand	1.12 mty	10	200
C&A Minerals Inc.	Tar sand	P.R. Spring area 30 miles north of I-70	20,000 bpd	300	2,116
Chevron Resources	Phosphate mining	11 miles north of Vernal	2.0 mty	25	920
Moon Lake 1 and 2	Coal-fired power plant	3 miles northwest of Bonanza	500 Mw	200	3,934
Plateau Refinery	Refining	Eastern Roosevelt	20,000 bpd	75	0
Enercor-Mono Power (P.R. Springs)	Tar sand	T. 15 S., 15-1/3 S and 16 S. R 22. E. and 23 E.	50,000 bpd	1,500	1,737
Enercor (Rainbow)	Tar sand	T. 12 S., R. 25 E.	5,000 bpd	273	8,343
Ramex	In-situ oil shale gasification	2 miles south of Moon Lake Power Plant	20 mcfd	50	640
Sohio Asphalt Ridge	Tar sand	8 miles southwest of Vernal	15,600 bpd	770	4,583
Western Tar Sands Inc.	Tar sand	Uintah (40 miles southeast of Vernal on Raven Ridge)	5,000 bpd	7	640
SUBTOTAL				3,210	23,113
Utah Oil Shale Projects					
Paraho	Oil Shale	3 miles southeast of Bonanza	10,000 bpd	700	570
White River (U-a,U-b)	Oil Shale	5 miles south of Grand Valley	15,000 bpd	500	620
SUBTOTAL				1,200	1,190
Wyoming Non-Oil Shale Projects					
Alchem Mine and Allied Chemical Corp. Plant	Underground trona mine and soda ash plant	T. 19 N., R. 109 W.	2.2 mty	1,230	1,280
Bean Spring	Coal mine	T. 14 N., R. 103 and 104 W.	1 mty	150	5,590
Big Island Mine and Staufer Chemical Corp.	Trona mine and soda ash plant	T. 20. N., R. 109 W.	1.82 mty	691	1,200
Black Butte	Coal mine	T. 18, 19 N., R. 100, 101 W.	7 mty	550	14,250
Carbon Basin	Coal mine	12 miles southeast of Hanna	5 mty	885	2,500
Cherokee	Coal mine	30 miles west/southwest of Rawlins	6 mty	285	8,700
China Butte	Coal mine	25 miles southwest of Rawlins	4 mty	437	10,000

TABLE A-4-1 (Continued)

NO ACTION ALTERNATIVE, LOW LEVEL PRODUCTION
(1990)

Project	Project Type	County (unless otherwise noted)	Production	Workforce (Peak)	Acres Disturbed
		Wyoming Non-Oil Shale Projects			
Church and Dwight Co. Green River Works	Sodium carbonate and bicarbonate	T. 19 N., R. 109 W.	0.25 mty	250	0
Elko-Sorenson	Coal mine	3 miles west of Kemmerer	4.3 mty	604	2,100
FMC	Soda ash plant solution mining	T. 17 N., R. 110 W.	1 mty	100	1,200
Jim Bridger	Coal-fired power plant	20 miles northeast of Rock Springs	1,700 Mw	350	6,100
North Block	Coal mine	5 miles northwest of Kemmerer	1.4 mty	200	2,590
Red Rim	Coal mine	15 miles southwest of Rawlins	2 mty	195	5,700
Riley Ridge	Natural gas field; 254 wells and 4 processing sweetening plants	40 miles north of Kemmerer	2.8 mcfd	238	8,400
Savery PRLA	Underground coal mine	13 miles east of Baggs	4 mty	1,000	500
Skull Point	Coal mine	6 miles southwest of Kemmerer	1.5 mty	120	710
Tenneco	Trona mine and soda ash plant	T. 18 N., R. 109 W.	2 mty	700	200
Texas Gulf Chemical Co. Mine and Plant	Underground trona mine and soda ash plant	T. 20 N., R. 111 W.	2 mty	820	5
Vulcan Materials Co.	Soda ash plant solution mining	T. 15, 16, and 17 N.,R. 109 and 110 W.	2 mty	100	1,600
Westvaco Mine	Trona mine and soda ash plant	T. 19 N., R. 110 W.	2.8 mty	1,450	1,630
SUBTOTAL				10,355	74,255
TOTAL				23,900	112,602

Note: There are no private or existing oil shale projects in Wyoming.

mty = million tons per year
Mw = megawatts
bpd = barrels per day
mcfd = million cubic feet per day

TABLE A-4-2

NO ACTION ALTERNATIVE, LOW LEVEL PRODUCTION (2000)

Project	Project Type	County (unless otherwise noted)	Production	Workforce (Peak)	Acres Disturbed
		Colorado Non-Oil Shale Projects*			
SUBTOTAL				6,385	9,974
		Colorado Oil Shale Projects			
Cathedral Bluff (C-b)	Oil Shale	20 mi northwest of Rio Blanco	21,000 bpd	670	1,700
Chevron	Oil Shale	28 mi north of Debeque	50,000 bpd	1,980	3,550
Colony	Oil Shale	15 mi north of Grand Valley	48,000 bpd	2,050	3,550
Rio Blanco (C-a)	Oil Shale	22 mi east of Rangely	50,000 bpd	1,700	3,550
Union	Oil Shale	12 mi north of Grand Valley	50,000 bpd	2,000	3,550
SUBTOTAL				8,400	15,900
		Utah Non-Oil Shale Projects*			
SUBTOTAL				3,210	23,113
		Utah Oil Shale Projects			
Geokinetics	Oil Shale	22 mi south of Ouray	31,000 bpd	650	8,610
Magic Circle	Oil Shale	16 mi southeast of Ouray	16,000 bpd	400	775
Paraho	Oil Shale	3 miles southeast of Bonanza	10,000 bpd	700	570
Syntana-Utah	Oil Shale	5 mi. east of Bonanza	17,000 bpd	790	1,160
Tosco	Oil Shale	13 mi. southeast of Ouray	24,000 bpd	1,520	4,570
White River (U-a U-b)	Oil Shale	5 mi south of Bonanza	50,000 bpd	1,680	620
SUBTOTAL				5,740	16,305
		Wyoming Non-Oil Shale Projects*			
SUBTOTAL				10,355	74,255
TOTAL				34,090	139,547

Note: There are no private or existing oil shale projects in Wyoming.

bpd = barrels per day

*See Table A-4-1 for data for individual projects.

TABLE A-4-3

NO-ACTION ALTERNATIVE, HIGH LEVEL PRODUCTION (2000)

Project	Project Type	County (unless otherwise noted)	Production	Workforce (Peak)	Acres Disturbed
		Colorado Oil Shale Projects			
Cathedral Bluff (C-b)	Oil Shale	20 mi northwest of Rio Blanco	76,000 bpd	2,100	5,325
Chevron	Oil Shale	28 mi north of Debeque	100,000 bpd	3,950	7,100
Colony	Oil Shale	15 mi north of Grand Valley	48,000 bpd	2,050	3,500
Mobil	Oil Shale	6 mi north of Grand Valley	50,000 bpd	1,900	3,550
New Prototype	Oil Shale	Piceance Basin	25,000 bpd	1,050	1,775
Superior/Pacific	Oil Shale	25 mile west of Meeker	15,000 bpd	530	380
Rio Blanco (C-a)	Oil Shale	22 mi east of Rangely	100,000 bpd	2,700	7,100
Union	Oil Shale	12 mi north of Grand Valley	90,000 bpd	2,600	6,390
SUBTOTAL				16,880	35,120
		Utah Non-Oil Shale Projects*			
SUBTOTAL				3,210	23,113
		Utah Oil Shale Projects			
Geokinetics	Oil Shale	22 mi south of Ouray	73,000 bpd	3,010	9,345
Magic Circle	Oil Shale	16 mi southeast of Ouray	32,000 bpd	2,100	2,540
Paraho	Oil Shale	3 mi southeast of Bonanza	42,000 bpd	1,600	1,125
Syntana-Utah	Oil Shale	5 mi east of Bonanza	57,000 bpd	2,100	4,310
Tosco	Oil Shale	13 mi southeast of Ouray	45,000 bpd	2,330	4,625
White River (U-a, U-b)	Oil Shale	5 mi south of Bonanza	100,000 bpd	3,355	2,575
		Wyoming Non-Oil Shale Projects*			
SUBTOTAL				10,355	74,255
TOTAL				51,325	166,982

Note: There are no private or existing oil shale projects in Wyoming.

bpd = barrels per day

*See Table A-4-1 for data for individual projects.

TABLE A-4-4

PROPOSED ACTION, LOW LEVEL AND HIGH LEVEL PRODUCTION (2000)

Project	Project Type	Location	Production	Workforce (Peak)	Acres Disturbed
		Low Level			
Colorado Federal Leases	Oil Shale	Piceance Basin	80,000 bpd	3,360	5,680
Utah Federal Lease	Oil Shale	Uinta Basin	40,000 bpd	1,680	2,840
TOTAL				5,040	8,520
		High Level			
Colorado Federal Leases	Oil Shale	Piceance Basin	280,000 bpd	11,760	19,880
Utah Federal Leases	Oil Shale	Uinta Basin	80,000 bpd	3,360	5,680
Wyoming Federal Leases	Oil Shale	Washakie Basin	40,000 bpd	1,680	2,840
TOTAL				16,800	28,400

Note: Assumptions used to develop these projects are discussed in Chapter 3, Introduction. The projects are the same as shown on the no-action alternative tables.

APPENDIX 5

TYPICAL OIL SHALE DEVELOPMENT TECHNOLOGIES

Since the EIS is limited to analyzing the effects of implementing a federal oil shale program, and not any site-specific proposal, specific development proposals could not be provided. This appendix provides an overview of general oil shale technologies which could be applied to the areas that may be leased if the proposed management program is implemented. Detailed description of technologies is provided in An Assessment of Oil Shale Technologies, (U.S. Office of Technology 1980). Chapter 8 of that document describes the impacts which may be expected from oil shale development. The Uintah Basin Synfuels Development EIS (BLM 1982g) provides an in-depth discussion and analysis of impacts from proposed oil shale development in the Uintah Basin of Utah.

Production of petroleum products from oil shale (oil shale development) requires extraction and refinement of kerogen, the organic matter contained in shale. Present development involves destructive distillation, either below ground (in situ), or aboveground in furnaces (retorts). The resulting fluids, gases, and solids must be refined or altered for use or disposal.

The mode of occurrence and character of the oil shale determine the method to be used for recovery. Deeply buried, relatively thin layers of rich oil shale are generally mined and brought to the surface for processing. Deeply buried, thicker, less rich deposits would be more economically retorted in place (in situ). Shallow deposits can be retorted in place (in situ) or surface mined and processed aboveground.

The various methods of mining, retorting, and their general impacts are described in this appendix.

The method of mining oil shale is determined primarily by its depth of burial. If the rates of overburden thickness to shale richness is favorable, surface mining, strip or open pit, would be used, depending on topography. These methods can recover as much as 90 percent of the oil shale for processing. In some places, shallow oil shale deposits may be retorted in place without mining, termed true in situ (TIS). Where the oil shale is too deeply buried to be surface mined or retorted in place without mining, underground mining methods would be used. Such methods generally recover no more than 60 percent of the ore.

SURFACE MINING

On the peripheries of the Piceance, Uinta, and Wyoming basins, where the oil shale may not be deeply buried, mining by either strip or open-pit methods, as done for coal and other resources may be employed economically. Strip mining, a method of surface mining (see Figure A-5-1) consists of removing overburden to expose the oil shale resource in parallel strips. This is followed by removal of the ore and backfilling with overburden. The overburden is generally excavated by a dragline and dumped into a previously mined area. Both the overburden and ore may require blasting to enable removal. The ore is generally loaded by front-end loaders and hauled by trucks. In the case of

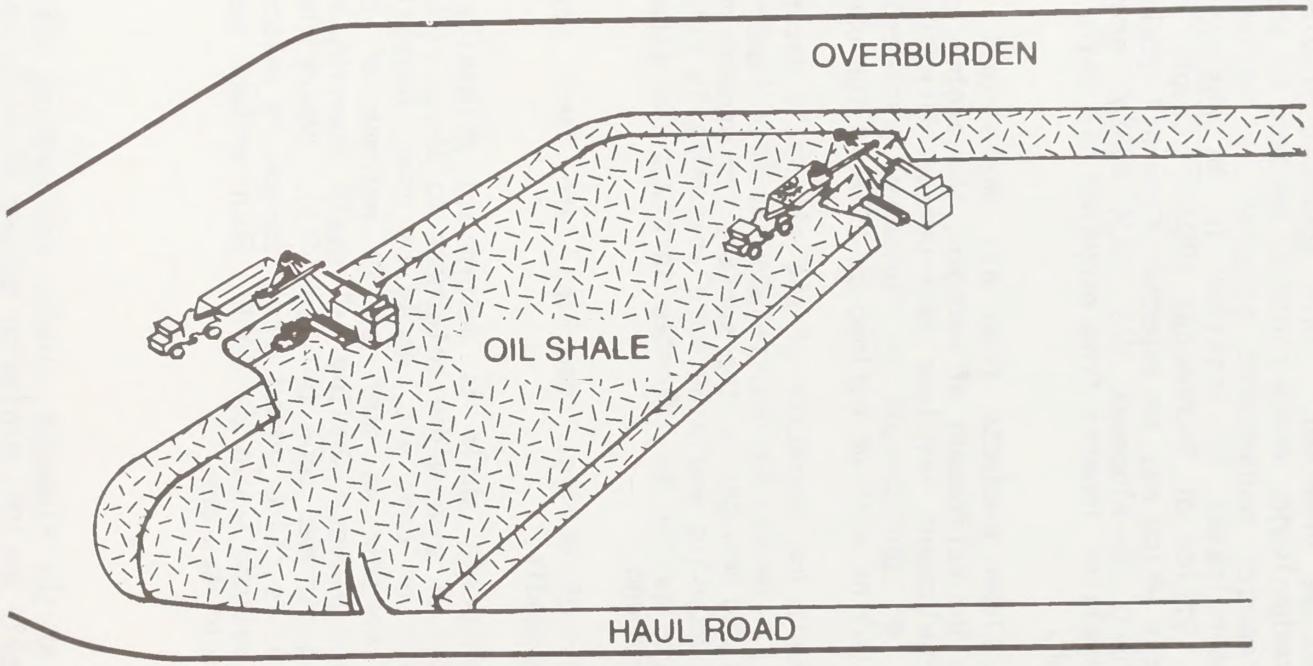


FIGURE A-5-1 STRIP MINING PROCESS

oil shale, the retorted shale waste would be buried beneath the overburden. Strip mining techniques succeeds in recovering more than 90 percent of the resource.

As with surface mining of coal, during the oil shale strip mining operation, the entire land surface is disturbed. Operations would affect wildlife habitat, surface drainage, ground water discharge, surface and ground water quality, air quality, agriculture (mostly grazing), and visual resources and would destroy archaeological and paleontological sites. However, much of the disturbed area could be returned to conditions prior to surface mining through rehabilitation and select portions of the area could have the potential for improvement, especially for grazing, wildlife, and recreation (including hunting). The extent of any impact will be determined by the diligence with which existing laws, regulations, and stipulations are observed and enforced.

Extremely thick oil shale layers covered by thin overburden can be obtained by a form of surface mining called open pit mining (Figure A-5-2) in which removed overburden generally is not replaced in the excavation after mining. Overburden and waste must be transported away from the mine and, unless replaced, results in a significant change in the topographic characters of the landscape. Replacement of retorted oil shale, whose volume is greater than the shale in place, would permit restoration of original landforms. Open pit mining can recover more than 90 percent of the resource and where physically appropriate would be the most economical method of obtaining oil shale. Initial disposal of overburden and retorted shale requires land in addition to the mine area. This method was proposed for the C-a tract in the Piceance Creek Basin, Colorado; but permission to use additional land for disposal was prohibited by law (Dayton 1981). The major impact of this method would be a significant alteration of topography. Potential erosion and air and water pollution impacts would be controlled by existing air and water regulations.

UNDERGROUND MINING

Where oil shale is too deeply buried to be recovered by surface mining, it either must be mined and retorted underground or mined and brought to the surface for retorting. Figure A-5-3 illustrates four underground mining methods. Although numerous methods have been considered for underground mining of oil shale, only one has been tested.

After extensive testing at the Anvil Points experiment station, the Bureau of Mines adopted the room-and-pillar method of underground mining for structurally sound, high-grade ore (U.S. Office of Technology 1980). This method recovers about 60 percent of a high grade layer of oil shale but would not recover the many tens of feet of lower grade oil shale. The ore is brought to the surface for retorting.

Cameron Engineers (1976) evaluated all potential systems for mining the deeper oil shale deposits of the Piceance Basin. Among these four variations (1) chamber and pillar (modification of room-and-pillar); (2) sublevel stoping with backfilling, (3) sublevel stoping with subsidence, and (4) block caving were analyzed in detail as being the most promising. In addition to high

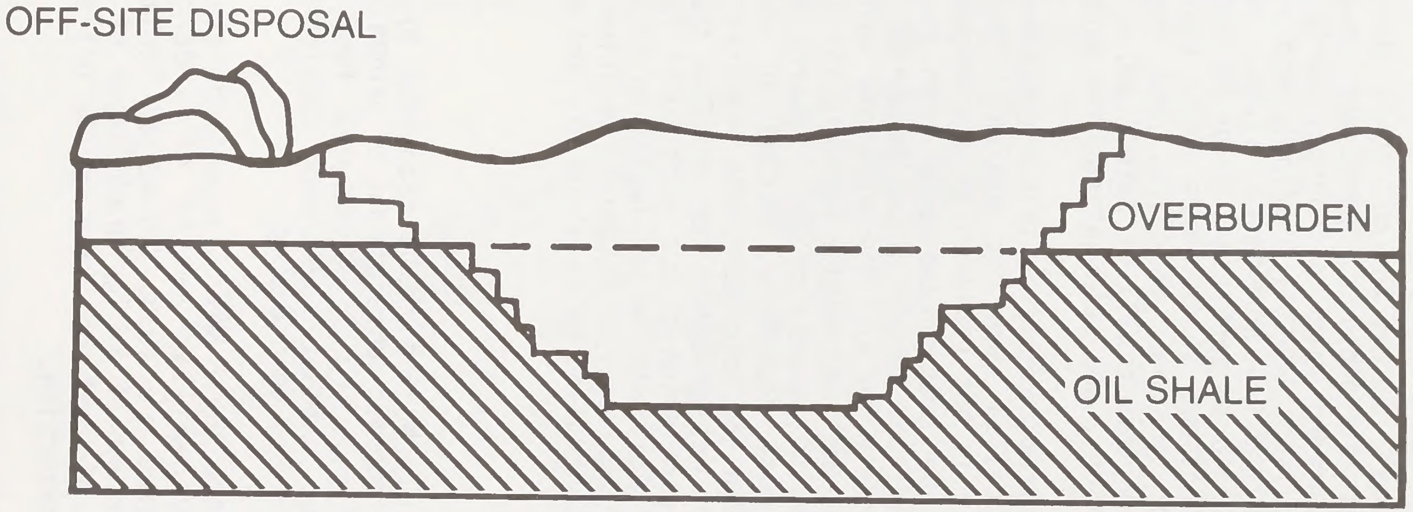
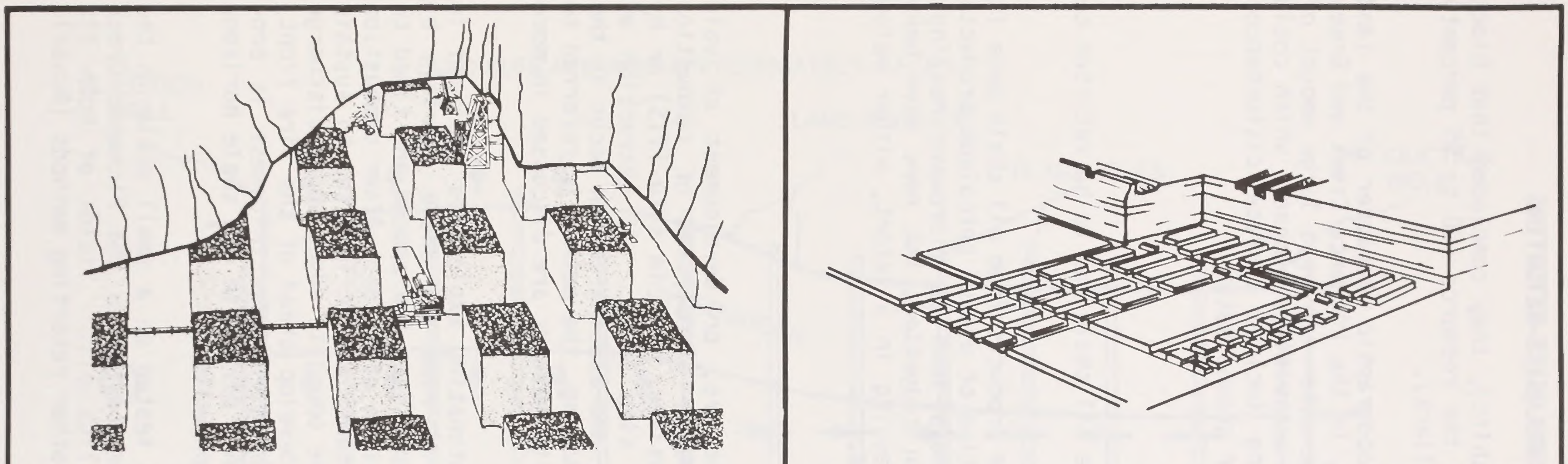
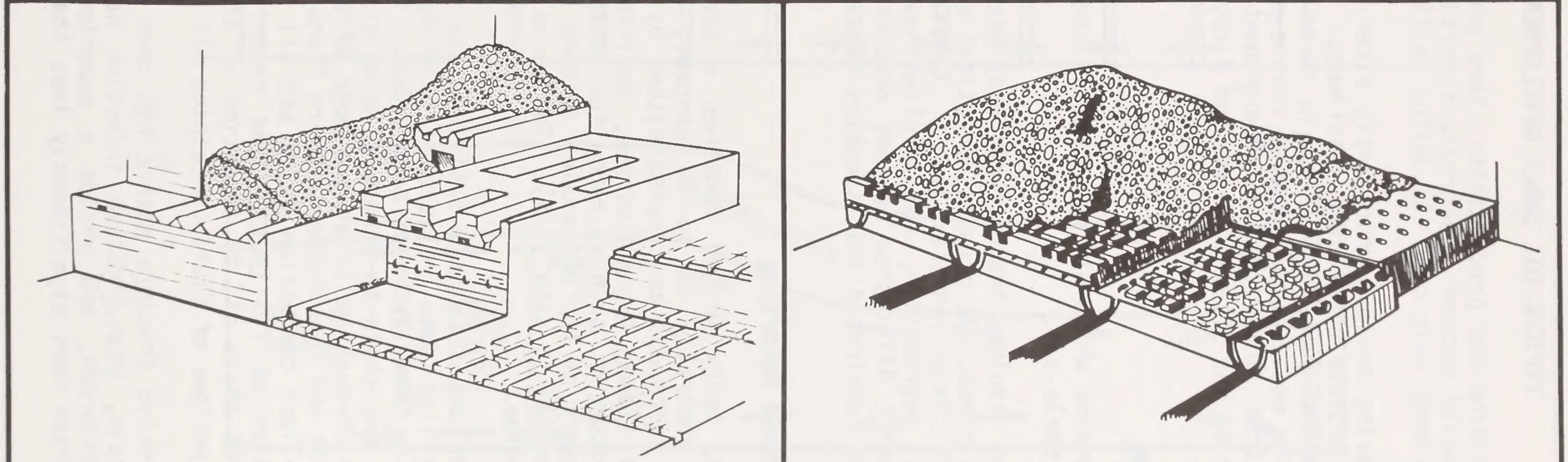


FIGURE A-5-2 OPEN PIT MINING PROCESS



1. ROOM AND PILLAR

2. SUBLEVEL STOPING WITH BACKFILLING



3. SUBLEVEL STOPING WITH SUBSIDENCE

4. BLOCK CAVING

FIGURE A-5-3 UNDERGROUND MINING PROCESSES FOR RECOVERING OIL SHALE

mechanization and productivity (tons per manshift), they concluded that block caving would recover the greatest portion of the resource (90 to 95 percent) at the lowest unit cost ($1.34/ton in 1975 dollars).

Block caving could significantly alter the topographic character of the land surface because of drastic subsidence. Also, in the Piceance Creek and Green River basins where the oil shale is below the water table, a large amount of dewatering would be required to enable mining activities. Impacts which could result from this form of underground mining include surface disturbance, subsidence, and effects of use and disposal of ground water.

RETORTING

Regardless of which mining method is used, the oil shale has to be retorted to produce shale oil.

Retorting involves the extraction of petroleum products from oil shale once it has been mined. At present, practical extraction of useful petroleum products from oil shale requires heat. Exotic methods such as microwave heating, bacterial degradation, and solution have been suggested; but none have been prototyped. All tested methods require processing in a retort, either below ground or fabricated and assembled aboveground.

Below Ground Retorting

Retorting below ground requires a permeable ore, or development of void spaces, generally 20 to 40 percent, to enable circulation of combustion gases. Voids can be created either by explosives, true in situ (TIS) or by mining followed by explosives, modified in situ (MIS). If extraction of other resourçes, such as nahcolite, soda ash, and alumina (which occur in the lower layers of the oil shale) is done by leaching, the method is referred to as integrated in situ (IIS). The three in situ methods are discussed in more detail below.

TIS retorting (Figure A-5-4) consists of detonating explosives emplaced in holes drilled into relatively thin layers of rich oil shale overlain by relatively thin layers of overburden. The explosives are spaced and timed to fracture the shale to create an even distribution of voids. After combustion is begun through wells at one edge of the retort, air is injected to sustain combustion and to advance the fire front to the opposite edge, where discharge wells collect combustion gases and oil that develop ahead of the fire front. A variation of TIS that is not restricted by overburden thickness is production of shale oil by injection of steam into permeable oil shale horizons and extractions of fluid containing oil through wells.

The explosive fracture method has been field tested on a small scale in the Uinta Basin, Utah. Steam injection has been tested in the Piceance Creek Basin, Colorado, and yields a superior quality oil. Yields of both TIS methods have been significantly less that by other retorting methods (Russell 1981).

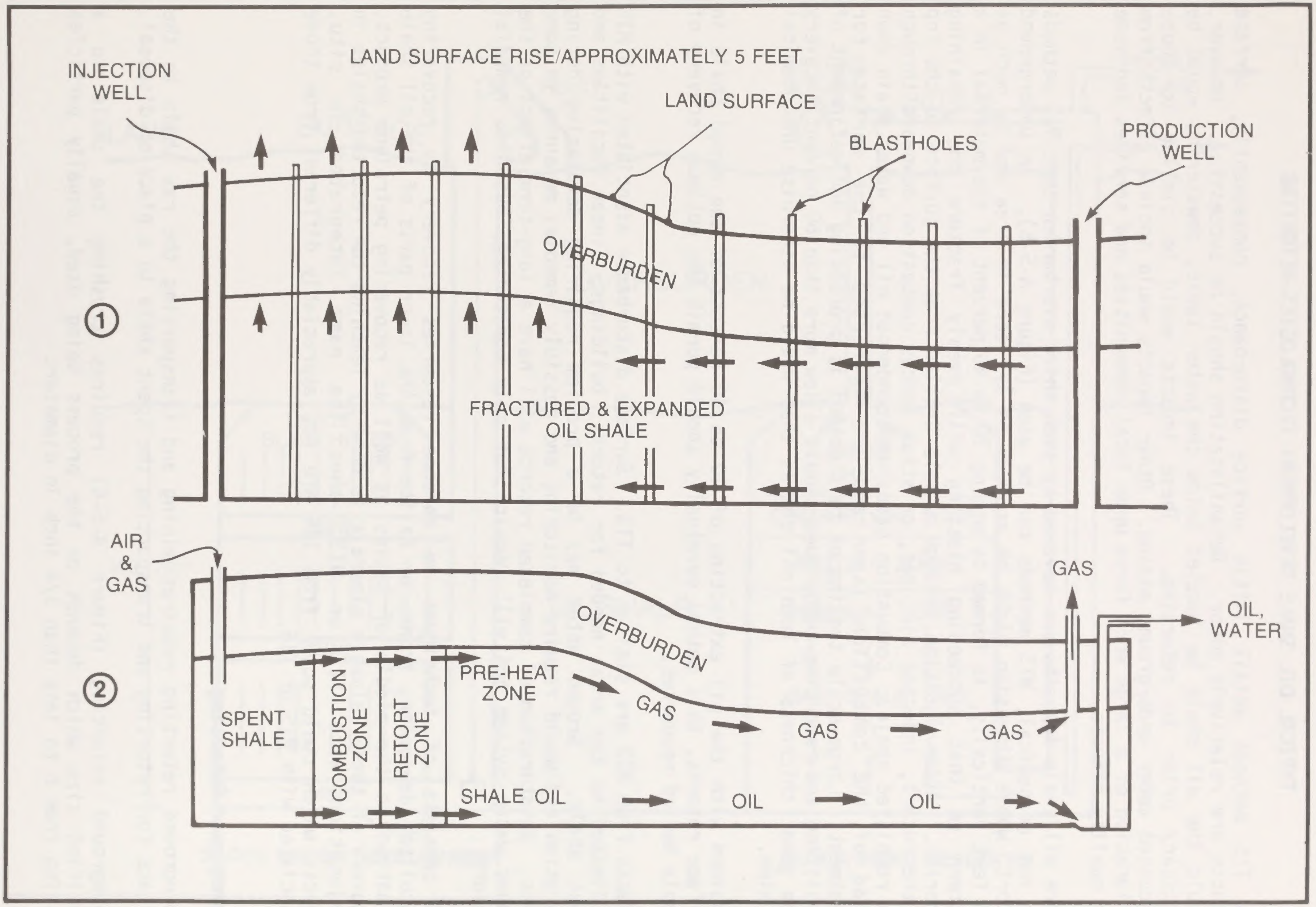


FIGURE A-5-4 TRUE IN-SITU RETORTING

The TIS methods entail little surface disturbance, consequently, surface impacts are relatively minor. Rehabilitation should be successful. However, should the oil shale be located below the water table, dewatering would be necessary prior to retorting. These impacts would be similar to those discussed under underground mining. Other impacts would include effects from immigration of a large work force upon local communities and services and some air quality effects.

Where oil shale deposits are covered by such thick overburden that TIS methods are not economical, MIS methods can be used (Figure A-5-5). An underground retort, whose dimension might be as much as 1/2 acre in area and as much as 700 feet vertically, is formed by mining 20 to 40 percent of the material in a pattern so that succeeding blasting will evenly fracture the remaining material. After ignition through a hole drilled from the surface to the top of the retort, injected air, gas, or steam forces combustion downward through the rubblized shale. Combustion gases and condensed oil and water drain down ahead of the combustion layer and are extracted to the surface for treatment. Large-scale testing of this method is proceeding and refinement of rubblizing and retorting techniques should allow more than 60 percent recovery from great thickness of lean oil shales that would be otherwise uneconomical to mine.

Combined with the oil extraction of 20 to 40 percent of the mined shale in surface retorts, this method eventually should permit the optimum recovery of deeply buried resources.

Effects from MIS are similar to TIS. Surface disturbance associated with MIS is limited to the areas needed for retorts, buildings, linear facilities and spent shale. Ground water may be a problem requiring dewatering during operation and would require monitoring and possibly remedial measures in some areas. Resaturation of completed retorts will have a long-term effect on the ground water system and will require not only monitoring, but also remedial measures.

IIS consists of techniques to enhance resources recovery by recovering nahcolite, dawsonite, trona, or halite from the lower parts of the oil shale formation in the middle of basins as well as recovering petroleum product. Recovery of these valuable minerals is done by leaching the retorted shales in conjunction with TIS or MIS, thus the name integrated in situ. Impacts which could occur from IIS are not appreciably different from those associated with MIS or TIS.

Aboveground Retorting

Aboveground retorting requires mining and transporting the raw shale to the surface for retorting and transporting the spent shale to a place of disposal.

Aboveground retorting (Figure A-5-6) requires crushing the shale to a specified size which depends on the process being used, usually particles ranging from 6 to less than 1/4 inch in diameter.

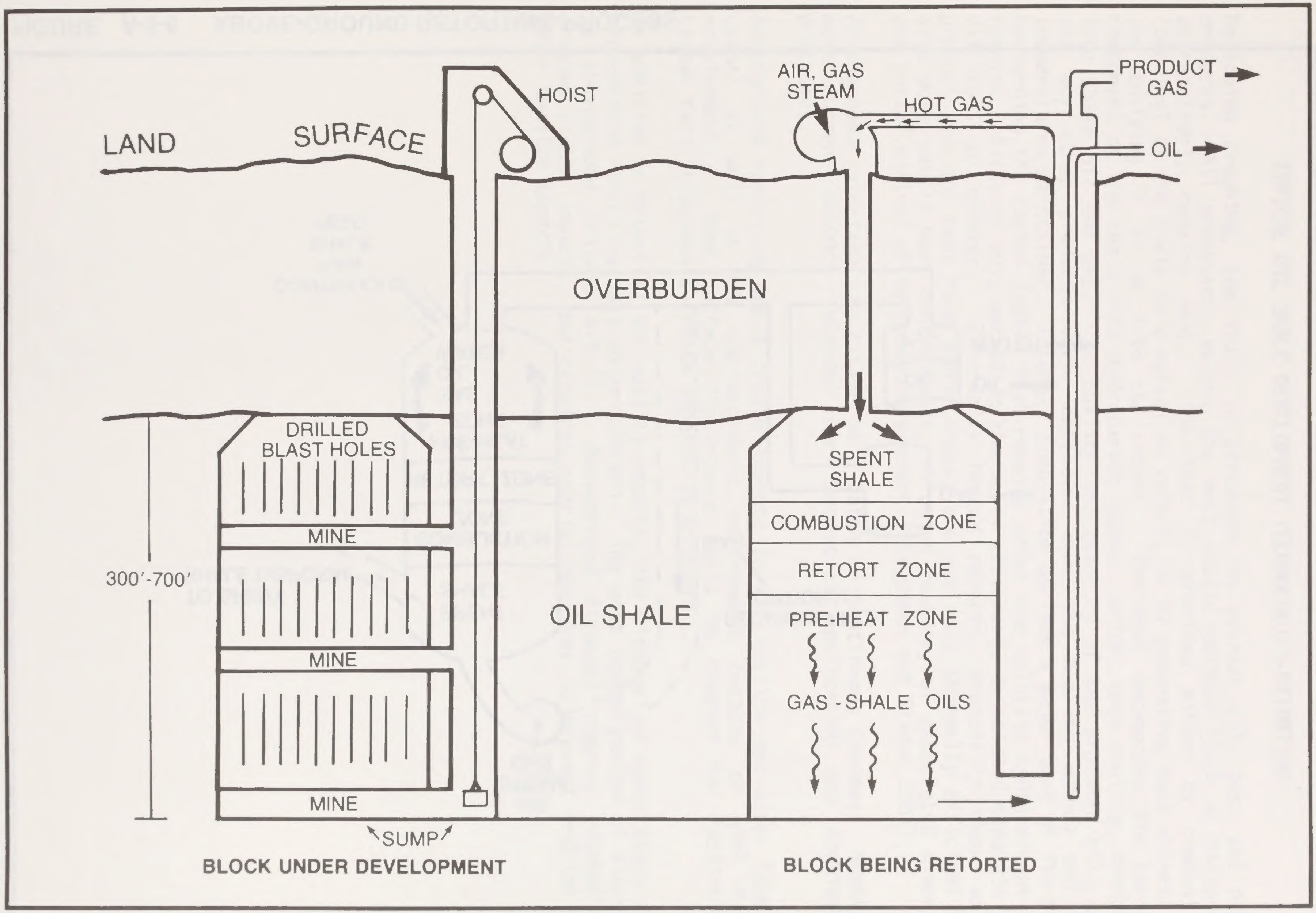


FIGURE A-5-5 MODIFIED IN-SITU RETORTING

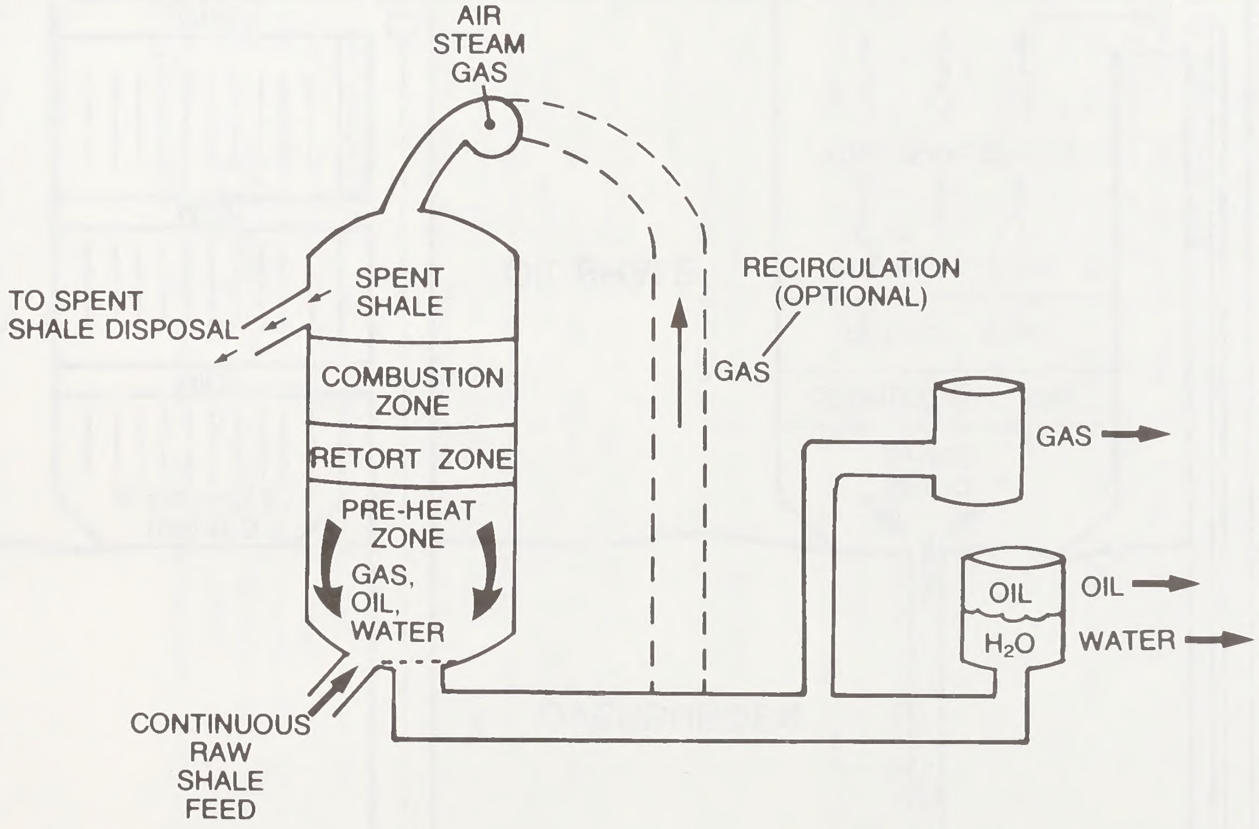


FIGURE A-5-6 ABOVE-GROUND RETORTING PROCESS

TYPICAL OIL SHALE DEVELOPMENT TECHNOLOGIES-RETORTING

Following crushing, the shale is processed to extract oil, gas, and other products. All processes, except the most exotic methods (such as bacterial degradation), require heat. The heat is provided either by combustion (burning) of the shale in a vessel or retort; or by generating heat externally and applying it to or into the retort. The heat decomposes the kerogen component of the shale into hydrocarbon vapors, which, upon cooling, condense into shale oil and gas. The quality and quantity of the produced oil, gas, and any other products vary, depending upon the heating method and the temperatures maintained. Internal combustion derives a major part of its heat by burning the carbon (coke) that remains after the volatile hydrocarbons are removed. Although this method is thermally efficient, associated minerals are difficult to recover. Externally heated retorts, especially those using product gas and heat from spent shale, are not only thermally efficient but also more easily heat controllable, allowing recovery of associated minerals and better control of hydrocarbon products (Baughman and Sladek 1981).

Aboveground retorting can either be a batch or continuous process. However, most current methods intended for commercial application are continuous processes.

Aboveground retorting would create impacts to air quality and water (due to usage) as well as the socioeconomic environment because of work force requirements. Some surface disturbance would be created for facilities. Linear facilities would create impacts to wildlife.

In addition to potential air quality impacts, the disposal of spent shale from aboveground retorting is a major concern. The most common method of disposal is aboveground (Figure A-5-7). Aboveground disposal removes vegetation, creates visual impacts, and requires special measures to prevent erosion and water quality impacts.

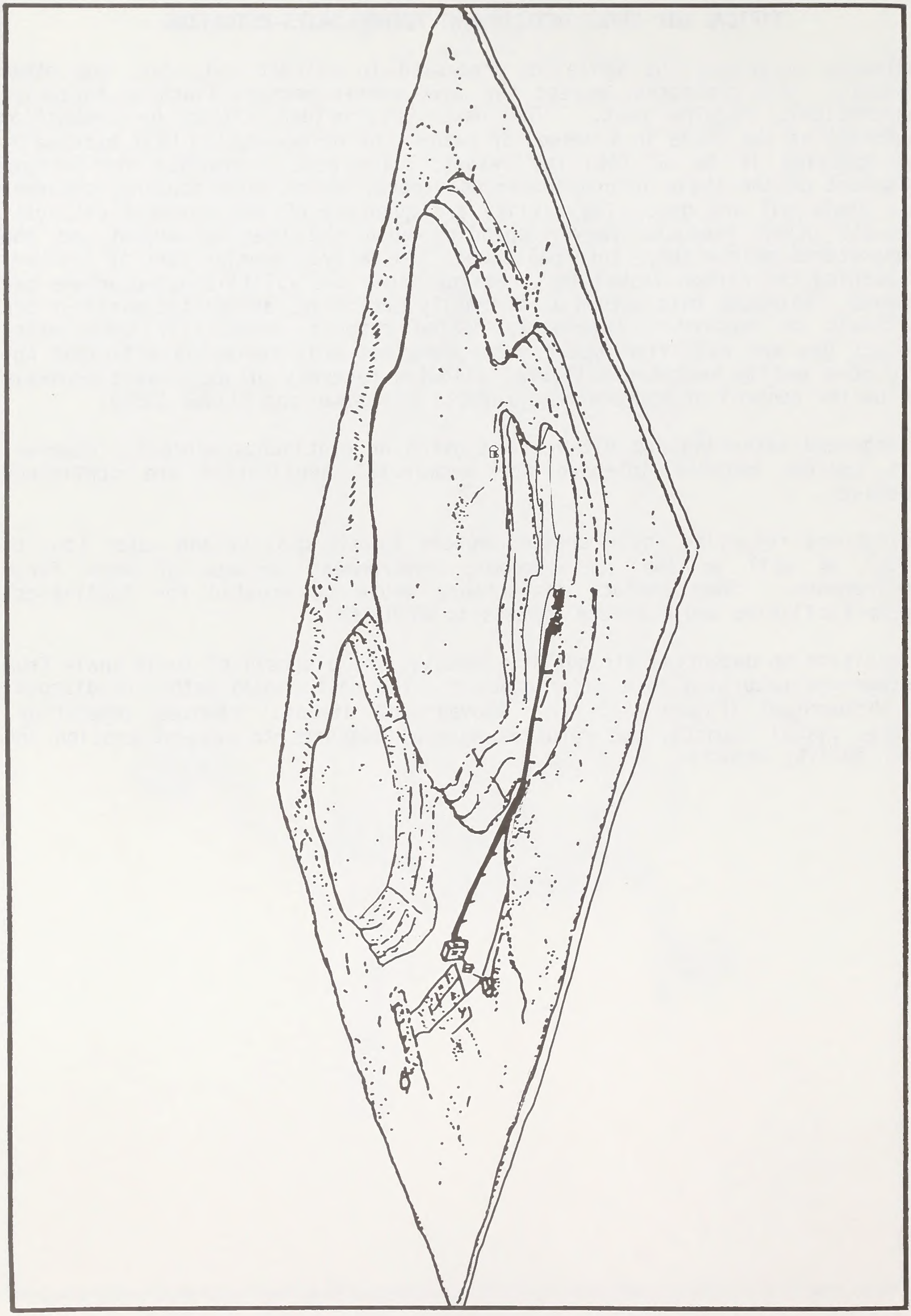


FIGURE A-5-7 TYPICAL ABOVE-GROUND SPENT SHALE DISPOSAL SITE

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PUBLIC HEARING REGISTRATION FORM

For public hearing on the proposed Oil Shale Management Regulations and draft Environmental Impact Statement for the Federal Oil Shale Management Program.

(Please Print)

To: Jack D. Edwards, Division of EIS Services, First Floor East, 555 Zang Street, Denver, Colorado 80028

From: Name ____________________

Street Address ____________________

City, State ____________________ Zip Code ________

Representing ____________________

I wish to appear at the Grand Junction public hearing on March 29, 1983, to express my views on the adequacy of the EIS.

I intend to submit a written documentation: Yes ________ No ________

____
Signature

Verbal testimony will be limited to 10 minutes; written testimony will be accepted at the above address until close of business on April 11, 1983. Registration forms are to be submitted by March 25, 1983. Registration will also be accepted at the door for the hearing.

Form 1279–3
(June 1984)

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